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LECTURES

ON

PRACTICAL PHARMACY

BY

BARNARD S. PROCTOR

FORMERLY LECTURER ON PHARMACY AT THE COLLEGE OF MEDICINE
NEWCASTLE-ON-TYNE

SECOND EDITION

WITH ADDITIONS AND CORRECTIONS

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PREFACE TO SECOND EDITION.

In preparing the first edition of my Lectures on Practical Pharmacy, my thought was simply to reproduce in print such matter as I had been in the habit of communicating to my class of students at the College of Medicine in Newcastle. I felt that while I was speaking through printed pages, I was still lecturing, though to a much larger class, and I had not realized, what has since become evident to me, that lectures in print should be available as a work of reference. I have myself frequently experienced difficulty in turning readily to information which I knew was contained in my pages. In preparing the present edition, I have kept in view the aim that it should not only be readable and instructive to the student, but should be readily made to yield the information it contains at the moment required. This I have endeavoured to accomplish by largely increasing the Index; by inserting here and there small items of useful information throughout the lectures; and by adding, as an Appendix, a few tables of useful matter. While the general plan of the work has been retained, the whole has undergone a careful revision; and a few alterations have been made which experience suggested, notably the addition of abbreviated formulæ of the pharmacopœial preparations at the head of the respective paragraphs in which they are commented on, it being convenient to have at hand the proportions as well as the list of ingredients under consideration. At the suggestion of several students I have concluded to place all the fac-similes of prescriptions at the end of the volume, for the sake of diminishing the temptation to turn to the printed commentary before all the instruction has been extracted from the fac-simile which it is capable of yielding. It has been thought desirable to avoid any considerable increase in the size of the volume, and with the view of doing this without excluding necessary additions, I have curtailed the lectures on Special Pharmacy—lectures which were originally intended as examples of, and incentives to, the experimental study of pharmaceutical problems. With the progress of pharmaceutical study, this object has become less important; consequently I have cut out the details of have carried out to anything like a satisfactory issue this part of my task, would have involved the expenditure of more time and space than I have had at my command. The reduction in the number of formulæ, the simplification of their characters, the elimination of useless matters, and the standardizing of all potent remedies, are the aims most worthy of the pharmacist's study and work. Something in this direction has also been attempted in the chapter on Supplementary Tests, a chapter which I regard as of the nature of a germ out of which better things may grow. The appended Table of Solubilities is in a very crude condition, and is almost entirely a compilation. The formulæ are not harmonious, being copies in most cases without alteration from the different sources of information where I sought the statements regarding solubilities; but I do not think the discordance in their forms will stand in the way of their utility to the practical worker, and as I have so frequently found convenience from a much shorter compilation of the same nature, I have thought it better to add it in its crude state than omit it from want of time to make it more creditable.

NEWCASTLE-ON-TYNE,
May, 1883.

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PRACTICAL PHARMACY.

LECTURE I.

Introduction—Division of Subject—Temperature for Drying Vegetables—"Vital Zone"—Drying Closets—Rate of Evaporation at x° Fahr.—Air Contains Aq.—Latent Heat of Steam—Evaporation over Oil of Vitriol—Use of Quicklime.

PHARMACY may be defined to be the study of remedies. Like most other sciences or arts of a miscellaneous nature, it is surrounded by other sciences, more definite, and generally more abstract in their character, which take, piece by piece, large sections from the province of Pharmacy.

Materia Medica, Therapeutics, Chemistry, and Botany, combined into one art, formerly constituted Pharmacy, but these sciences gradually becoming separate, the term Pharmacy is now applied to such ill-defined and unclaimed ground as has not yet been appropriated by any of these more abstract sciences. The duty of the lecturer on Pharmacy is, therefore, to give instruction in all the manifold subjects connected with the preparation of remedies, which are not already taught, or not sufficiently taught by the lecturers upon these previously-named subjects. To this task I will now devote myself; and, in doing so, I shall have to take it for granted that my audience have acquired the ground-work of the sciences I have enumerated, and that it is unnecessary for me to explain in detail many of the principles and laws upon which the operations under consideration depend; but, at the same time, I shall not hesitate to treat of any branch which may be connected with my subject, though the same may also belong to the province of another lecturer. I shall be guided solely by the desire to make the subject clear, systematic, and comprehensive, and the information imparted practically useful. I shall keep in mind that I am addressing *students;* and while I remember that their first object will be to qualify themselves for their examination, I will not forget that their ultimate object must be the acquirement of such pharmaceutical knowledge as will enable them to carry on their business with success to themselves and satisfaction to the public. I shall not offer any remarks upon the importance of my subject; for I do not expect to address any who are not convinced of the utility of acquiring, by every means within reach, a thorough knowledge of the art which it is my duty to teach. It is not my desire to tempt those who would otherwise be indifferent to this study, but rather to help those who have put their hands to the plough, with the determination to be industrious cultivators of the province of Pharmacy.

I shall count upon my hearers knowing beforehand a great and processes in operation; and with the view of ascertaining how far I am successful in my teaching, I shall from time to time hold examinations of my pupils, devoting part of an evening to questions upon the subjects treated of in several of the preceding lectures, and concluding with a recapitulation of the matter, with the view of enforcing any important points which do not appear to have been sufficiently apprehended.*

Practical Pharmacy may be divided into several sections, and though perhaps not a strictly scientific division of the subject, I have thought it most convenient to treat it under the following heads:—

Abstract or General Pharmacy,
Official Pharmacy,
Extempore Pharmacy, and
Special Pharmacy.

It may at first sight appear inappropriate to speak of any branch of an applied science or art as "abstract"; nevertheless, it is convenient to gather together under this heading a group of facts, principles, processes, and appliances which are so far abstract that they may be common to a large number of occasions, and in great measure independent of the material which may at one time or another be subjected to our manipulation. Thus, grinding may be said to be an abstract process, which will at one time be applied to tartaric acid, and at another to jalap root. Infusing is an abstract process, which will at one time be applied to calumba, at another to senna,—and it will facilitate the treatment of the whole subject, if under the head of abstract or general processes, all those matters are discussed which have a wide applicability.

Under the head of Official Pharmacy will be treated the processes of the Pharmacopœia, arranged in such groups as naturally assimilate, rather than in alphabetical order, which would bring in contiguity many processes having no natural connection. The several operations described in the first section—Abstract Pharmacy—will then be exemplified, with the various modifications necessary to meet the requirements of special cases.

---

* To the student reading these pages, it is recommended to follow the same system of self-examination.

Under the head of Extempore Pharmacy will be treated the operations of the dispensing counter, many of them bearing considerable analogy to the processes of the laboratory, but so far distinct as to require a special experience for their quick, accurate, and satisfactory performance.

By the term Special Pharmacy, I intend to express the application of pharmaceutical knowledge to the selection of suitable modes of treating special or individual drugs for obtaining their most desirable forms of administration. It will necessarily require some knowledge of the chemical nature of the drugs under consideration, and the means by which a convenient form may be attained along with uniformity of strength and permanence of condition.

Reverting to abstract processes, they may be classified according to their objects, and the mode in which that object is to be accomplished.

First, The division of a substance into smaller particles of a like nature, and the separation of finely-divided from coarse will leave a considerable number of processes unclassified, including distillation, sublimation, calcination, &c. All these processes are essentially simple in their nature; they are elements out of which we have to construct the complex processes required for the preparation of many pharmaceutical products. In the second division, these elementary operations will be used together in various degrees of complexity, up to the elaborate processes involved in the production of some of the organic acids and alkaloids. We will commence with the reduction of massive materials into the state of powder.

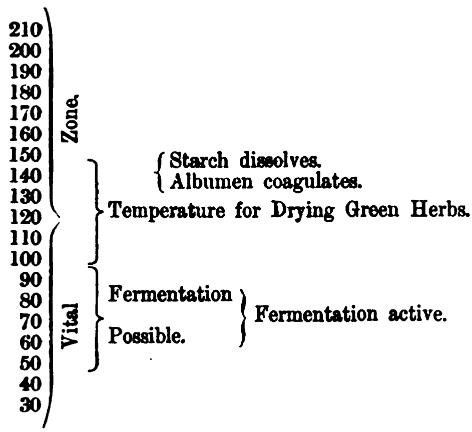
Inorganic substances, such as native minerals and salts, may generally be submitted to bruising or grinding without any preparation; but articles of vegetable materia medica will generally require to be dried, and we will first briefly consider the various appliances which have been devised for drying, together with general precautions requisite to avoid injury of the substance under treatment.

DRYING.

In tropical countries, little else is necessary to insure satisfactory desiccation than exposure to the air and sunshine, but in our own humid climate that cannot be trusted. Warmth and moisture are the essential conditions of rapid change in organized bodies. There is a zone of temperature which may be called the vital zone, within which the functions of animal and vegetable life are possible. The freezing and the boiling points of water may be considered the limits of active life, though in some recent experiments by Crace Calvert, reported in the *Pharmaceutical Journal* of 2nd September, 1871, satisfactory evidence has been found that infusorial life is capable of withstanding a heat of 300° Fahr. in infusions contained in hermetically sealed tubes, capable of bearing such a pressure as is involved by subjecting watery fluids to this temperature. He experimented upon solutions of sugar and of gelatine, and infusions of hay and of putrid meat; and in all cases found that a temperature of 212° Fahr. was insufficient to destroy the infusorial life which had made its appearance by keeping those liquors in contact with the air; and that in all cases, except the solution of gelatine, they continued in diminished proportion even after 300° Fahr. had been reached, but that in all cases a temperature of 400° Fahr. was sufficient to effect the total disappearance of vitality. According to these observations, the infusorial fungi are most readily destroyed, a temperature of 212° Fahr. being fatal to them; and the vibrios the least readily destroyed, their vitality continuing in solutions exposed to 300° Fahr., but not in those heated to 400° Fahr. He also found intense cold incapable of destroying these low forms of protoplasmic life; a liquor containing microzima and vibrios, on being frozen and retained for twenty hours at temperatures ranging between 32° Fahr. and 15° Fahr., still displayed living animalculæ on being melted, and the movements, which were languid on the first thawing of the ice, resumed their wonted energy in the course of a couple of hours.

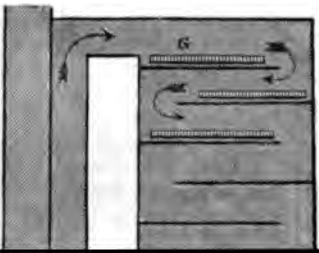
But though he has shown that the animalculæ did not lose their vitality, we have other evidence that the life was in a condition which we may call latent at the lower temperature, and it is not unlikely that the same may be the case when the temperature is above 212° Fahr.—that functions are languid, heat without injury. A little above 100° Fahr. we begin to find changes which are liable to affect more or less the properties of the body subjected to it. At 140° Fahr. starch, in the presence of water, swells and becomes soluble. At the same temperature albumen coagulates; between this and the boiling-point many vegetable substances of a complex nature also undergo changes. If, therefore, we set down 90° Fahr. as the lowest temperature to which vegetables can be continuously subjected in the presence of moisture without undergoing fermentation, and 140° Fahr. as the point at which danger from over-heating commences, we have indications of the suitable range within which all ordinary processes of vegetable desiccation may be performed.

HEAT OF DRYING CLOSET.



It must not be supposed, however, that temperatures both above and below those bracketed are not on many occasions both safe and desirable. I have indicated 90° Fahr. and 140° Fahr. as the points within which almost anything may be safely trusted, and wish to impress upon you that the usual heat of sunshine in the open air is much too low for advantageous work. It simply brings the material into the zone of most active organic change, the conditions for the greatest perfection of vegetable life being also those of most rapid destruction when the vital action has been interrupted. Common herbs are frequently dried by being hung from the ceiling of a warm, dry room, but where a large quantity has to be reduced to dryness in a short space of time, it becomes necessary to have recourse to special arrangements. In the drying rooms connected with drug-mills it is usual to spread the herbs, &c., upon trays heated by steam-pipes, the waste steam from the engine which drives the mill being a cheap and convenient mode of applying a heat a little under the boiling point. The usual forms of drying closets, in addition to providing the heat requisite for evaporation, are so arranged as to cause a rapid current of air over the moist materials. The accompanying sketch (Fig. 1) will show the arrangement. A is

Fig. 1.



arrows show the direction of the current of air. As the fire draws all its air from the closet, it insures a sufficient ventilation, and as all the air which enters the closet has to pass up the flue E, which is kept hot by its contiguity to the fire and the chimney, its condition, being clean, warm, and dry, is most favourable for promoting evaporation. The illustration represents the shelves arranged to cause a serpentine passage of the air over the trays.

Many modifications of this arrangement have been contrived to suit special conditions. I will only draw your attention to one which I have devised myself, and which will probably be found suitable for the operations which most of you will have to perform in the discharge of your duties as pharmaceutical or dispensing chemists.

It consists of a series of trays of thin iron-plate, so constructed as to pack away within one another when out of use, thus being convenient from its economy of space, especially for the use of those who have not daily occasion for its services. When put in operation, the lowest tray, which is also the smallest, is heated by a row of small gas jets placed at one end, at which end there are also perforations to admit air; the edges of the tray being about two inches high, the next tray may be placed upon it, leaving space enough for the moist material and the current of air which is to play over it. The second tray has similar perforations to those in the first, but placed at the other end, so that the air has to pass over the whole length of the first tray before it can ascend through the openings in the bottom of the second. A third, fourth, and fifth tray may be added, if required, taking care that the openings are in alternate ends, so as to ensure a serpentine channel for the heated air. I do not suggest this as an arrangement suitable for those who have desiccation continuously going forward, but for the occasional use of the pharmaceutical chemist it will be found to have the following advantages:—

It is packed away in small space when not required, and may be set in operation at a minute's notice. It is equally convenient for a single tray, or for two or three trays, full of material, according to the requirements of the operation in hand. The heat is easily regulated by increasing or diminishing the supply of gas.

Green herbs, such as conium, hyoscyamus, and digitalis, should be dried at a temperature not exceeding 120° Fahr. It is, perhaps, to be regretted that the Pharmacopœia does not now give any instructions for the drying of articles of vegetable materia medica. But we have various authorities for stating that the temperature I have just indicated —120° Fahr.—should not be *exceeded* in the case of the more delicate materials; and as it is important that they should not long remain warm and moist, it is desirable that the temperature should not be lower than is required to insure their safety. On referring to the table* of the rate of evaporation of water at different temperatures, it will be seen that it takes twice as long to evaporate a given quantity of water at 100° Fahr. as it does at 125° Fahr., and it takes four times as long to evaporate the same at 79° Fahr. Various other circumstances, however, have a great influence upon the rate of evaporation,—most notably the percentage of moisture in the air, and the rapidity with which the air in contact with the

Under natural circumstances, air is never quite dry; it most nearly approaches this condition at low temperatures, but even at the freezing point 100 cubic inches of air will retain $\frac{1}{100}$ of a grain of water. We may also say that every material has a certain affinity for water, and the relation between the affinity of a given material for moisture and the percentage of moisture in the air will determine whether that given substance under these circumstances will lose or gain moisture.

Exp.—Two sheets of paper of the same nature in every respect, except that one is almost absolutely dry and the other palpably moist, when exposed to the air, one will gain and the other lose moisture, provided the air is in anything like a normal condition; but the air might be so moist that the moist paper would not part with any moisture, or it might be so dry that the dry paper could not absorb any. Either of these latter conditions, however, would only continue so long as the temperature remained steady; a fall in the temperature would enable the dry paper to absorb moisture; a rise would cause the moist one to part with some. To illustrate this action with pharmaceutical materials, I weighed out two portions of senna from the same drawer; each weighed exactly 50 grams* (=771 grains) in the condition of approximate dryness which senna possesses under ordinary keeping. One of these was kept upon the drying trays for ten hours, the other exposed to the damp atmosphere of the cellar. Two portions of squill root of a like weight were subjected to the same treatment. During the ten hours' drying the senna lost 58 grains and the squill 62 grains. During the ten hours' exposure to the damp atmosphere the senna gained 19 grains and the squill 10 grains. During three days' exposure the senna had made a total increase in weight of 60 grains and the squill of 30 grains; and to show that the gaining or losing of moisture by the exposure of a given substance to the air is determined by the relation which subsists between the degree of moisture of that substance and the moisture of the air, we now take these two samples of senna, the one palpably damp, and the other unusually dry, and expose them on sheets of paper to the air of the lecture-room. An interval of half an hour having elapsed, the damp senna had lost 10 grains, and the very dry senna had gained 10 grains, by exposure to the same atmosphere under the same circumstances; and no doubt a continued exposure there would in a short while result in the two samples becoming just equally moist—the exact degree of moisture ultimately attained being determined by the relation borne by the hygroscopic power of senna to the temperature and hygrostatic condition of the atmosphere. These experiments make no pretensions to precise accuracy, yet it is worthy of a passing note that the difference between the damp senna and that which was dried till it became crisp amounts to 118 grains of water, and that the squill root, which we usually regard as having a remarkable affinity for water, only differs to the extent of 92 grains. As the squill, especially when powdered, becomes sticky if slightly damp, our attention is drawn to the fact that powdered squill absorbs moisture be contained in 100 cubic inches under a pressure of about two atmospheres, but that pressure would fail to bring any portion of it back to the liquid form so long as the temperature did not fall below 248° Fahr.

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* A friendly critic has suggested that I should not mix up the use of grams and grains in one experiment. It was by chance that a 50-gram weight was used in the first instance, and the retention of the same was with the view of avoiding the probability of the numbers given being taken as generally applicable.

The quantity of water given in each case makes the air quite saturated, and it is only when far removed from this point that evaporation can be conducted at all advantageously. A glance at the table will show how enormously the rise of a few degrees increases the desiccating power of the air, and where economy of time is important, how great is the inducement to use as high a heat as possible; and since hot air soon becomes charged with moisture when in contact with wet materials, how important it is to keep up a constant current, so that there is always a thirsty atmosphere replacing the moist before it becomes saturated. All this necessity for heat could not exist unless the heat were in some sense "consumed," and in this instance it disappears in the form of latent heat. The quantity thus consumed in converting water into steam varies slightly according to the temperature at which evaporation is taking place; but at the boiling point, the quantity required to convert 1 lb. of water into 1 lb. of steam of the same temperature would be sufficient to raise it to 1178° Fahr., or to a bright red heat, had it been a fixed body incapable of converting sensible into latent heat; or, in other words, it would have sufficed to raise about 8 lbs. of water from 60° Fahr. to the boiling point.

It has commonly been stated that water requires the same quantity of heat to convert it into vapour at whatever temperature the evaporation takes place, the quantity of latent heat of a vapour being greater at low than at high temperatures; but more recent researches have shown that this is not strictly true, as will be seen by a reference to the table of latent heat of water vapour:—

F.		Latent.		Total.
32	+	1090	=	1122
122	+	1027	=	1149
212	+	966	=	1178
302	+	903	=	1205
392	+	840	=	1232
482	+	774	=	1256

From Regnault in Gmelin.

Here you will observe that water evaporating at the freezing point, where it is only supplied with 32° Fahr. of sensible heat, absorbs 1090° Fahr. of latent heat, making a total of 1122° Fahr. But at the boiling point, where it acquires 212° Fahr. of sensible heat, it only renders 966° Fahr. latent, the total in this instance being 1178° Fahr. And that when boiling under high pressure, when it acquires 482° Fahr. of sensible heat, there are only 774° Fahr. rendered latent, the total increasing slightly with the rise in temperature at which the conversion into vapour takes place. This consumption of heat in evaporation causes considerable reduction of temperature in the air passing through a drying closet, except when the material is nearly dry, or of such a nature as does not permit rapid evaporation. The long serpentine course of the air is less advantageous when there is a considerable bulk of fresh herbs, the evaporation from which is so rapid that air entering at as high a temperature as can be permitted, becomes cooler than is advantageous before it passes over the last tray.

Substances which are difficult to dry without injury are sometimes placed in vacuo over oil of vitriol. The absence of atmospheric pressure very much expedites the volatilization of the moisture, and the oil of vitriol absorbs the watery vapour is very convenient for keeping powdered squill in good condition, which otherwise is so liable to become damp and sticky. It is also advantageous for the preservation of powdered ergot and other drugs which are apt to be injured by animalculæ or mould. For larger bulks of drugs tin canisters may be conveniently used, and dryness maintained by including a card box containing a lump of quicklime, and renewing the latter when it becomes completely hydrated. Thorough desiccation affords the greatest protection against this source of injury. The fact is, that like larger beings, the microscopic animals and plants find it very dry work living without water, so they die and allow the ergot to enjoy its existence in peace.

QUESTIONS FOR SELF-EXAMINATION.*

What changes do moist vegetables undergo by keeping?

At what temperatures do these changes proceed most rapidly?

The most palpable change in a vegetable by drying being loss of water, what other changes may it undergo?

What is generally the most desirable heat for drying vegetables?

Does change in temperature make much difference in the rate of evaporation?

What other circumstances besides change in temperature affect the rate of evaporation?

What becomes of the heat used in drying a moist substance?

Is the same quantity of heat lost in vaporizing water at all temperatures?

RECAPITULATION.

Herbs, &c., if kept moist, are liable to be affected by fermentation, mouldiness, and slow decay.

The two former of these changes are most rapid at about

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* The student is recommended, after reading a lecture, to test his knowledge of the matter by endeavouring to answer these questions, and then to compare his answers with the recapitulation which follows, or, if necessary, with the substance of the lecture itself.

70° to 90° Fahr., and may be considered to cease below 32° Fahr. and above 212° Fahr.

Vegetables, in being dried, lose water and volatile oils.

Some of their constituents may undergo oxidation, such as oils, resins, alkaloids, or acids. Starch may be rendered soluble. Albumen may be rendered insoluble.

The most generally desirable heat for drying vegetables is just above the fermenting zone, say 100° to 120° Fahr. The rate of evaporation increases in a high ratio with increase of heat, but is also affected by the dryness of the air and speed of its motion, by the pressure of the atmosphere, and by the compactness and hygroscopic properties of the moist material.

In converting water into vapour, about 1000° Fahr. become latent; but the quantity varies with the temperature at which evaporation takes place, the sum of the latent and sensible heat being 1122° Fahr. at 32° Fahr., and increasing a little as the temperature rises.

LECTURE II.

COMMINUTION.

Slicing Fresh Roots—Cutting Hard Woods—Species—Rule for Degree of Comminution—Bruising and Grinding—Steel Mills—Stone Mills—Sifting—Effects of Powdering—Experiment on Starch—Washing—Powdering Red Oxide of Mercury—Camphor.

Almost every solid substance used in medicine requires at some time to undergo mechanical division, either to fit it for direct medicinal use, or for some subsequent process. The nature of this mechanical division, and the means by which it is effected, will vary very much according to the physical nature of the substance to be operated upon, its crude condition before it is subjected to comminution, and the degree to which the comminution is to be carried. The substance after treatment will frequently not only have changed its mechanical condition, but also in some degree its chemical composition.

Our attention will now be given to the general objects of comminution, the means of effecting it, and the changes of a chemical nature which are apt to be involved.

To commence with the most crude and simple operation, certain succulent vegetables, such as the bulb of squill and the root of calumba, are sliced to promote their subsequent drying and preservation. To avoid the loss of juice a sharp instrument should be used, and to promote drying the cutting should be transverse to the fibrous and vascular tissues of the plant. A blunt instrument, by bruising the vessels, will cause much loss of juice, and it must also be remembered

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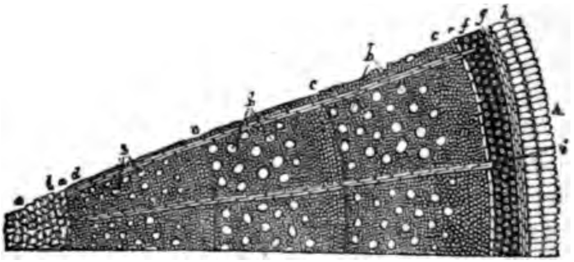
that the transverse section, while it most promotes desiccation, also endangers the loss of juice more than a longitudinal division, which, while it may reduce the substance to equally small particles, does not to the same extent lay the vessels of the plant open.

You will appreciate this difference if you count the number of cells laid open in an equal surface of the two sections of a dicotyledonous stem. You will find the structure fully described in "Bentley's Botany," from which work the following engravings are taken.

Fig. 2.



Transverse Section of a Dicotyledonous Stem three years old.

Fig. 3.

the same time the roots are not so bulky as to require division to promote their desiccation.

If, on the other hand, the object is to reduce a vegetable substance to a condition suitable for expressing its juices, the more completely the vessels are opened and torn asunder the better; but even in this case it will be readily seen that a transverse section will most facilitate the expression of the juice. The instruments used in slicing vegetables are generally of the simplest possible nature, and are no doubt familiar to you all. Common pruning shears are very convenient for the smallest operations of this kind. There are sundry forms of root knives or choppers, which are suitable for working on rather larger quantities or more bulky materials, the object being to gain power by the use of a long lever, which constitutes the handle of the knife, while the short arm of the lever forms the hinge which fixes the knife to the block supporting the substance to be cut; the support is advantageously curved to prevent the root from slipping under the edge of the cutter.

With any of these appliances the task of reducing woody materials to slices is very laborious, and when required to be performed on the large scale, recourse is generally had to a lathe and turners' tools, as in the case of quassia, guaiacum, &c.; but as this does not come within the province of the pharmaceutist, it is not necessary to enlarge upon the subject.

Dry substances which have been reduced by slicing, when compared with those which have been comminuted to an equal degree by other means, such as crushing in a mortar or mill, will be found to be more free from dust, consequently will more readily produce a clear infusion or decoction if required for that purpose. They are also more readily penetrated by the water.

It was formerly the custom to sell chopped herbs, either mixed together or separate, under the name of species, from which herb teas, &c., were to be prepared; and though it is often convenient to have the materials for an infusion or decoction ready for its speedy preparation, it is not desirable to have sundry ingredients mixed together, unless they can be suitably reduced to a rough powder, as materials in a *coarser* state of division—especially if part is fine and part rough—will not long continue to be uniformly mixed. If so fine a state of division is not desirable, the species should be put up in packets suitable for making a definite quantity of the resulting liquor—say a pint or a quart—each ingredient being weighed into each packet to insure uniformity. The degree to which comminution is to be carried for any particular class of purposes cannot be fixed, but two or three principles may be stated which have a general bearing upon the question.

The more compact a material is the more minutely will it have to be divided to secure a satisfactory result.

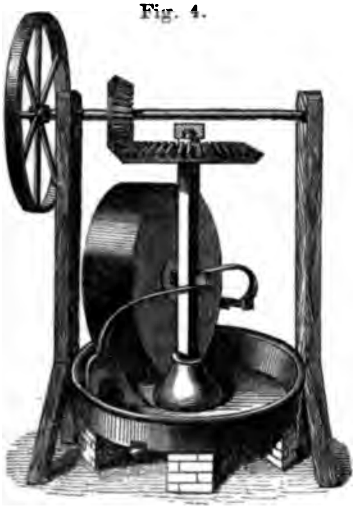
The less soluble it is, or that portion of it is upon which its activity depends, the higher state of division, *ceteris paribus*, will it require.

The less it is capable of expanding under the influence of the solvent the finer it should be comminuted. Thus vegetable substances generally swell more under the influence of water than under that of spirit, and consequently require to be more finely divided for making tinctures than for infusions, and as hot water causes a more rapid and complete expansion of the generally do, bruising and grinding are both frequently done in the mortar by simple manual power, the process being so familiar as to require scarcely any notice. As I stated in my lecture on drying, thorough desiccation is usually an essential preliminary to the grinding of vegetable matter, and I only need now to refer to it as marking a difference in the nature of the coarse and fine comminution—the former, effected by cutting, being usually performed with at least equal facility upon the fresh herbs, &c.; the latter, depending upon the brittleness and friability of the material, requires the removal of the water which adds so greatly to the pliability and toughness of most organized structures.

Steel mills are also very useful and convenient for grinding drugs where an impalpable powder is not essential, and they have the advantage of not requiring such absolute dryness as is necessary for grinding with stone, on which account preference should be given to them where the material contains active volatile matters, such as essential oils. The form so familiar as coffee or pepper mills will answer perfectly for a variety of purposes. It is essential to have them so constructed as to be readily and thoroughly cleansed between operations with substances of different natures. After grinding caraways or aniseed, the mill should not only be brushed out, but exposed to the air, to allow the evaporation of the essential oil with which it will have become impregnated, before it can be used for any other material. Steel mills may be considered applicable to vegetable substances only, while stamping mills, mortars, and stone mills may be used for every variety of materials. The stamping mill may be looked upon simply as a mortar beaten by machinery, and is frequently used as a preliminary to grinding under stones.

Stone mills are constructed upon two plans—one being the form usually employed in grinding flour, consisting of two horizontal grindstones, the lower being fixed, and the upper revolving upon it. The material, in a rough state, but not in large lumps, being placed in a hole in the centre of the upper stone, is drawn in by the motion of the stones, and torn to pieces, gradually becoming finer as it progresses from the centre to the circumference of the stone. As it leaves the stone it is in a powder varying in fineness according to the nature of the material, &c.; it may then be sifted, and the rough portions returned to the mill.

Fig. 4.



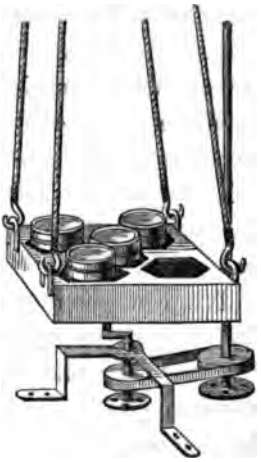
The other form of mill more commonly used in drug grinding, consists of one or two edge-stones running in a trough, the general arrangement of which will be best understood by reference to Fig. 4. The stones are necessarily thick, hard, and heavy, and usually run in a trough of cast iron. You will readily perceive that a stone such as that shown in the diagram would run in a straight line if free from guiding power, and if forced round in a small circle, such as will revolve at about the same velocity as it progresses, and on one side of that line the stone will tear the material under it, in consequence of its revolving faster than it progresses, and on the other side of that line it will have the same action from revolving more slowly than it progresses.

The mere crushing force of the heavy stone rolling over the material would of itself reduce any brittle substance to powder, but tough and fibrous substances require a tearing action as well as direct pressure.

In grinding with the horizontal stones, the weight of the upper stone is diffused over a large surface; but in the edge-stone the whole force and weight are concentrated upon a few inches.

It is said to be most economical, both of time and material, to let grinding and sifting alternate pretty frequently, and when the whole is finished, if the substance in hand be not homogeneous, it is necessary to mix the first sifting with the last, as the more friable portion which passed through first will frequently differ in nature or in the proportion of some active constituent from the more fibrous or tougher portion which has come through last. The sifting apparatus is usually the same as the familiar drum-sieve, and is kept in motion by the machinery which turns the millstones. A tray or shallow box (Fig. 5), containing several drum-sieves, is suspended by ropes from its corners, attached to the ceiling. A crank attached to the bottom of the box causes it to revolve, not on its axis, but round a fixed point in the floor; and as a jerking motion promotes the sifting, advantage is taken of the fact that a round sieve does not move smoothly if loosely fitted into a square hole. The cover of the box has angular holes to receive the sieves, large enough to allow of their

Fig. 5.



being shaken from side to side as the box revolves in the horizontal plane.

Other forms are sometimes used for articles the consumption of which is so large as to justify special sifting apparatus. A conical revolving sieve, such as used in flour mills, may then be adopted. It consists of a cone of wire gauze in a sloping position with the wide end higher. The sieve revolves in one direction, and a system of brushes fitting its interior revolve in the opposite direction. The material is continuously supplied to the wide end of the cone, and is brushed through as it runs down; only those portions which are too coarse to pass through run out at the narrow end.

When sifting powders which are not homogeneous it is necessary to bear in mind the risk, I might almost say the certainty, that the first and last portions to pass through the sieve will not be identical, and should be mixed together finally by stirring.*

In some cases it is desirable to separate powders into particles of about uniform size, which is done by sifting through two sieves, the coarse sieve separating all the particles above a certain size, and a fine sieve separating all those below a certain size; there is thus obtained a sandy powder which is

To obtain the fine and rough powders, a quantity of the medium powder is sifted through a sieve considerably finer than that it was first passed through. All that passes through this second sieve is known as fine powder, while that which will not go through is the quality known as rough powder; but besides the mere fact of its consisting of larger particles, the particles are much more uniform in size, and, as a consequence, it is much less prone to agglomerating than either the fine or medium powder.

Mills and sieves, if their use be not confined to one material, will require thorough cleaning between the operations. Washing is objectionable, as the repeated wetting and drying are destructive of the machinery; to avoid this it is a common practice to grind and sift saw-dust in small successive portions till it comes through clean—a practice which is in itself unobjectionable, but which, it is said, led at one time to frequent adulteration of vegetable powders with the first portion of saw-dust which, having passed through the mill, came out pretty strongly impregnated with the material last ground.

The frequency with which powders are now subjected to chemical and microscopical tests has nearly put an end to such practices; but the protection which we derive from a higher public morality in some cases, and the action of public analysts in others, should not entirely take the place of the chemical and microscopical examination of purchased powders, for the purity of which every pharmacist should feel himself personally responsible.

The legitimate effect of powdering is, in the majority of cases, an increase in the strength from loss of water, and from separation of inert matter in the form of gruffs, such as the fibrous part of ginger root, the woody part of ipecacuanha, the husks of mustard and cardamom seeds, &c. Others, again, lose valuable volatile matters; powdered myrrh never makes so good an emulsion as the soft cheesy lumps of the crude article, and cinnamon, caraways, &c., part with essential oil. Saline matters are apt to lose water of crystallization, mainly in consequence of the drying which precedes the grinding. The disintegration of starch, the coagulation of albuminous matter, the oxidation of some constituents, or the rendering insoluble of others, are changes which are liable to take place from the same causes, and more liable in drugs which are powdered than in those which are dried without being also powdered.

We have already considered the increased facility for extraction of soluble principles from vegetable substances imparted by their division, but a few words more on that subject will be useful in connection with the changes produced by grinding. I shall have to treat of solution, diffusion, osmosis, &c., in a subsequent lecture, and cannot enter into these questions now, except just to point out that the whole vascular and cellular systems of plants contain deposits of one kind or other, some of which when in solution will readily pass through moist tissues, and others which, under the same conditions, will only pass with the utmost slowness; and there are some tissues which water will penetrate with the greatest facility, and others which are almost impenetrable, even when immersed for a long time. As I do not wish to anticipate the matter of a future discourse, I will only select one example, and demonstrate the facts by an experiment.

It rarely happens that any considerable number of the granules are broken in grinding ordinary drugs (as may be ascertained by filtering cold infusions of powdered ginger, calumba, &c., and testing them by the addition of a drop of tincture of iodine), but if the cells are broken which contain the starch—and this is always the case in fine comminution—it is much more freely dissolved in hot water than is the case if the material is roughly divided, and a comparatively small number of starch cells laid open. You all know how much boiling will be borne by barley without its being dissolved, though it is about 70 per cent. starch; but if the barley be first ground, the bulk of it will be dissolved by simply infusing in boiling water. Then we may take an illustration in which it is not desirable to dissolve the starch. Sarsaparilla root contains its active principles in the bark, and its farina in the pith; but as the latter renders the decoction no more active, but more prone to become thick and mouldy, the Pharmacopœia now directs the root to be cut into convenient lengths, but not split open, as was formerly the custom; consequently we now have a decoction equally active, but less liable to decomposition than formerly.

For experiment, a sample of split sarsaparilla boiled a few minutes in water gave a copious blue precipitate with tincture of iodine, while a decoction of the unsplit root was not changed by the addition of this reagent.

The case of starch is probably an extreme one, but there are sundry mucilaginous principles which are not freely soluble nor freely diffusible when contained within the cells of vegetables, but which become readily diffused through an infusion if the comminution has been carried so far as to disintegrate the cells and expose their mucilaginous contents to the direct contact of the water.

There are some few instances in which a material may with advantage be ground wet; this was formerly done with shells, coral, calamine, chalk, &c.; but the use of the two former has died out, and the preparation of chalk does not fall into the hands of the pharmaceutist, so that the subject requires no further notice than to allude to the process of washing, which in these cases takes the place of sifting. The powdered material being mixed with a large bulk of water, is allowed to settle for a short time; the upper part, containing the matter in a fine state of division, is then decanted, and by long repose is allowed completely to deposit its contents, which are subsequently collected, drained, and dried, while the rough portion, which had subsided rapidly, is either rejected or submitted to a second trituration. In the case of chalk, of course, the object is to get rid of sand, and the material being of little value, a considerable portion is thrown away; but when operating upon a valuable and homogeneous substance, such as the red oxide of mercury, the levigation may be repeated till every particle is reduced to a fine condition. Levigation on the small scale is performed either in a mortar or with a slab and muller. The minutiæ of the operation can only be learned by practice, and will differ according to the material in hand. The red oxide of mercury appears to me to grind best when only moist; in that condition it may be readily made so fine as to lose almost entirely the glistening appearance which it usually possesses, and until this is accomplished it is scarcely tendency to cohere again is to a small extent increased until the temperature falls again. Heat is the most advantageous aid in powdering spermaceti, spirit best in powdering camphor. There are some circumstances in which the use of spirit is not desirable in the powdering of camphor, and then it is well to remember that fixed or volatile oils and soap also have the effect of promoting its division; and as they have not the volatility of spirit, the powdered camphor obtained by their use is not so prone to agglomeration.

QUESTIONS FOR SELF-EXAMINATION.

What are the principal varieties of comminution?

What kinds of materials are usually divided by cutting?

In what direction are they best cut?

What is the most notable difference between coarse comminution effected by cutting and by bruising?

If species are kept for infusions, &c., what irregularity are they liable to introduce, and how should it be avoided?

What circumstances determine the degree of comminution to which a substance should be subjected in preparation for maceration?

What classes of substances are most necessarily ground in steel mills?

What classes belong exclusively to stone mills?

In what respects are powdered drugs likely to differ from those which have not been subjected to powdering?

What substances grind better when not dry?

RECAPITULATION.

Comminution includes cutting, bruising, and grinding, the first being used for fresh vegetables and hard woods, which are most advantageously cut transversely, the product thus obtained being less dusty than that produced by bruising. Comminution should be carried further; the more compact the material, the less it expands in the solvent in which it is to be macerated, and the more difficulty there is in dissolving the active matter. Comminution should be most perfect when an insoluble drug is to be administered in suspension.

Steel mills are advantageous for tough materials, vegetables containing essential oils, &c.; stone mills for such as can be dried till they become friable, and for salts and mineral substances. Powders are likely to differ from the massive drugs in having less water, essential oil, or other volatile matter, and in having less woody fibre or husk; they are more ready to yield soluble matter to solvents, and are more liable to accidental or wilful impurity.

Red oxide of mercury is better ground damp. Camphor is most readily powdered by rubbing with a little spirit. Heat is the most advantageous aid in powdering spermaceti.

LECTURE III.

SOLUTION.

Classes of Solutions in British Pharmacopœia—Solution Defined—Solubilities Compared—Solvent Powers Compared—Effects of Temperature on Solubility—Presence of "A." affects Solubility of "B."—Freezing Mixtures—Rapidity not Proportionate to Degree of Solubility—Automatic Stirring—Supersaturation.

MECHANICAL division, if carried to its utmost, fails to convert a solid into a fluid. Yet we can scarcely look upon a solution as being other than a solid body divided into its ultimate molecules and mixed with the solvent. At the same time, many of the phenomena of solution are such as we do not readily bring within this simple mechanical theory. A consideration of these phenomena will afford us much interesting matter for thought, and the pursuit of our calling affords us many occasions in which all the information we can obtain relative to the theories or the facts bearing upon this subject will be acceptable.

In looking over the contents of the Pharmacopœia, we observe not only a variety of operations, but a variety of *classes* of operations depending upon solution, and our time will not be ill spent in glancing at each, with the view of estimating the subject-matter of our present study before we go into theoretical considerations.

First, there is a class of liquors, or "simple solutions," in which a solid substance is dissolved in a liquid which does not alter its composition or properties, but will, on evaporation, leave it in the same condition as before it was dissolved.

Then there are cases of "chemical solution," in which the body dissolved enters into a more intimate combination with some portion of the solvent, and is not capable of being restored to its original condition by simple evaporation, as in the preparation of perchloride of iron or saccharated solution of lime.

Again, there are instances in which solution is the means of separating active from inert matter, as in the case of infusions, decoctions, tinctures, wines, vinegars, &c.

A fourth class, in which chemicals of different degrees of solubility are to be separated from each other by the subsequent processes of precipitation, crystallization, or simple washing.

A fifth class, in which a liquid is made to dissolve a gas, as in the preparation of solution of ammonia, or solution of carbonate of magnesia.

And a sixth class, in which one liquid is made to dissolve another, as in the preparation of spirit of chloroform or liniment of mustard.

You will readily perceive how various must be the processes by which these operations are to be performed, how many circumstances will influence the production of solutions of these very different natures, and how often there is scope for the exercise of intellectual faculties, and the application of

In simple solution the taste, odour, colour, and combining powers remain the same, but in chemical combination they are generally quite changed.

In simple solution, if one, and only one of the materials used is volatile before the union, it continues to be so after the union, and may be separated by evaporation, leaving the other possessed of the same or nearly the same properties as before. Zinc will dissolve in diluted sulphuric acid, but the acid cannot be separated again by evaporation, because it has entered into chemical combination; but sulphate of zinc will dissolve in water, and the water may be separated again by evaporation, because the union has been only that of simple solution. And to illustrate the difference between solution and mixture,' or suspension of a material in a liquid, the solution of sulphate of zinc may be set at rest for any length of time without subsidence taking place. Though the sulphate is heavier than the water, the bottom of the solution never becomes stronger by settling;* had it been a mechanical mixture, such as might be made of hydrated oxide of zinc and water, a gradual subsidence would have taken place.

It is difficult to come to a satisfactory definition of solution, because of there being many exceptions to the sundry general rules which form our best guide to its comprehension; enough, however, has been said to give a tolerably correct idea of the matter.

I will first draw your attention to the solution of solids in liquids, and more particularly in water, for when we speak of a body being soluble or insoluble, the statement, if not otherwise indicated, has reference to water as a solvent. Its solvent powers are more extensive than those of any other fluid known. There are scarcely any chemical compounds, except alloys,

* In dense solutions which have been standing at rest in closed vessels for a considerable time, there will sometimes be observed a stratum of lighter liquid on the top, not resulting from any subsidence, but from the solvent having vaporized and recondensed upon the upper part of the vessel, and then run down again, and is found floating upon the heavier liquor. This is most frequently seen when a solution has been bottled while warm.

which we have not reason to believe are to some extent soluble in water, but the degree of solubility is extremely various. We may take a few examples as illustrating this point.

Chloride of silver is soluble in 2,000,000 times its weight of water, but not in 1,000,000.

Sulphate of baryta is soluble in 800,000 times its weight of water, but not in 400,000.

Oxalate of lime requires about 500,000 parts of water.

Magnesia is soluble in 55,000 parts of water.

And sulphide of copper in 950,000 parts.

Looking to the other extreme, we find crystallized chloride of calcium is soluble in one-fourth its weight of water, and fused chloride of zinc in one-third of its weight of water.

So far I have spoken of the comparative solubility of various substances in one solvent, viz., water.

It is also interesting and instructive to compare the solubility of a substance in various solvents.

One part of camphor is soluble in—

1000 of water.
150 of water with magnesia.
1 of alcohol sp. gr. 815.
⅓ of chloroform.

Showing that there is as great a diversity in the behaviour of a substance with sundry solvents, as there is in the behaviour of one solvent with sundry substances.

It is a general if not a universal rule, that heavy solids, when dissolved in water, add to both its density and bulk, the density of the solution being usually a safe guide to the percentage of the solid in solution. An illustration of this rule is found in Dalton's table of the density of solutions of caustic soda.

DENSITY OF SOLUTIONS OF SODA.*

Aqueous Sol. Sp. Gr.	Contains per cent. NaO.	Boils at
2·00	77·8	Red heat.
1·85	63·6	315·56 C.
1·72	53·8	204·44 C.
1·63	46·6	148·89 C.
1·56	41·2	137·78 C.
1·50	36·8	129·44 C.

The addition of 0·1 sp. gr. indicating about 7 per cent. of NaO, the proportion being pretty constant throughout the table.

The table of density of acetic acid illustrates the exceptional cases.

ACETIC ACID.†

Sp. Gr.	Per cent. of $C_4H_4O_4$ Glacial or Monohydrate of $C_4H_3O_3$.	Sp. Gr.	Per cent. of $C_4H_4O_4$ Glacial or Monohydrate of $C_4H_3O_3$.
1·001	1	1·0732	77
1·002	2		78
1·004	3	1·0735	79
1·010	7		80
1·015	10	1·0732	81
1·020	14	1·0730	82
1·025	18		to
1·029	21		90
1·040	30	1·0700	95
1·050	39	1·0680	97
1·060	50	1·0655	99
1·070	68	1·0635	100
1·0730	76		

There are two popular errors which I should wish to caution you against, which may be refuted by an examination of these and other tables of a similar nature, which you will find in your handbooks, more especially in Storer's "Dictionary of Solubilities." *

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* Storer's "Dictionary of Solubilities," p. 454.

† Mohr, in Storer, p. 2.

I have heard it repeatedly stated that, if the density of a solution is expressed in relation to water as 1000, 1000 being subtracted from the density, the subtrahend expresses in grains the quantity of the solid in a fluid ounce. Now, if we calculate from the solution of soda, sp. gr. 1·50 (saturated at ordinary temp.), according to the rule given $1500-1000=$ 500 grains of soda in a fluid ounce. A fluid ounce of this density would weigh 656 grains, which, at 36·8 per cent., gives only 245 grains in a fluid ounce—the popular rule indicating in this instance double the true quantity. To make another calculation from the table of density of acetic acid—

$1050-1000=50$ grains in a fluid ounce; but a fluid ounce of this density will weigh 458 grains, and at 39 per cent., as indicated on the table, will contain 178 grains of acetic acid. Thus the rule indicates more than twice the true quantity of soda, and less than a third of the true quantity of acetic acid. From an inspection of this table you will also observe that the addition of glacial acetic acid to water increases its density; and even when the acid thus obtained has the same density

CHLORIDE OF SODIUM SOLUTIONS.*

Sp. Gr.	Per cent. of Sol.	Sp. Gr.	Per cent. of Sol.
100·725	1	111·146	15
101·450	2	115·107	20
102·899	4	119·228	25
105·851	8	120·433	26·395 (Sat.)
107·335	10		

If we add 1 part of salt to 99 of water, it will yield a 1 per cent. solution, the density of which, according to the table, is 100·725; but if it had added nothing to the bulk of the water, its density would have been 101·010, as will be seen from the following calculation; the solution under these circumstances would, of course, measure 99 and weigh 100, its density being as 99 : 100 : : 100 : 101·010. A similar calculation would give the density of a 20 per cent. solution as 125·000 instead of that obtained by experiment, 115·107. It is therefore evident that, whether we add 1 per cent. or 20 per cent. of salt to water, the bulk of the water is increased by the addition.

No satisfactory theory has been propounded by which to explain why one salt should be soluble, and another almost insoluble, in the same fluid. Silver, tin, zinc, and lead are very similar substances, and we cannot say why their chlorides should include the extremes of solubility and insolubility in water.

But in some other cases we can trace what may be a rule in embryo, namely, the much more general solubility that exists between solids and liquids of a similar nature or constitution than that which exists between bodies of different natures. The solubility of oils, resins, fats, &c., in other oils, spirit, ether, &c., and their general insolubility in water, contrast with the generally sparing solubility of metallic salts in oils, ether, &c., and their generally free solubility in water. There are also some groups of substances having more or less analogy among themselves, which keep that analogy in their relationships to solvents. Thus the essential oils, having a general and physical analogy, much resemble one another in their degree of solubility in water and other solvents; and the alkaloids agree in being sparingly soluble in water, usually more soluble in spirit, and so on.

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* Gerlach, in Storer's "Dictionary."

In the preceding cases we have spoken of solubility at ordinary temperatures, and we have next to consider the influence of change of temperature upon solution.

The general effect of a rise in the temperature is an increase in the solubility of solid substances, and a diminution in the solubility of gases. But there are sundry exceptions to the first section of this rule. Common salt is just about as soluble at the freezing point as at summer heat, though at the boiling point its solubility is slightly increased. Sulphate of soda increases in solubility rapidly from the freezing point up to 92° Fahr. (33° C.), about the temperature of the body, at which heat water will dissolve about five times its weight of the crystallized sulphate of soda,[*] but the solubility decreases again as the temperature rises, till at 178° Fahr. (81° C.), when water will take up only about double its weight of the crystals; above which temperature the solubility again increases up to the boiling point—the weight soluble at this temperature being about 2½ times the weight of the water.

Hydrate of lime and sulphate of lime are also much less

Leaving the question of temperature, I will next direct your attention to the effect which the presence of one substance has upon the solubility of another. In cases where the solubility is increased, it is generally supposed that some chemical change takes place; but there are many instances in which that can scarcely be admitted. The well-known instance of corrosive sublimate being more soluble in the presence of alkaline chlorides is explained by the fact that double chlorides of mercury and sodium, &c., are formed, which are more soluble than the simple mercuric salt. But the equally familiar example of the increased solubility of iodine in the presence of alkaline iodides cannot be accounted for in the same way; the iodine has every appearance of being dissolved, but not combined. It retains its dark colour and peculiar odour, and will volatilize and collect upon the upper part of the tube in its original condition. As a further experiment, we pour a solution of perchloride of mercury into a solution of iodide of potassium, and observe that the red iodide of mercury, which precipitates on the first contact of the liquors, dissolves into a nearly colourless liquid as it subsides through the solution of iodide of potassium. As soon as the latter becomes saturated with the former salt, we take a sample of the solution, and on evaporating obtain a pale yellow double iodide, showing that a chemical combination, as well as solution, had taken place. But taking a further portion of the red iodide, we find it soluble in hot saturated solution of chloride of sodium, yielding a solution with no more red colour than the former, but from which it is again deposited in the form of brilliant red crystals as the solution cools; thus the chloride of sodium appears to increase its solubility in hot water without forming a permanent compound.

There are many cases in which the increased solubility of one substance, imparted by the presence of another, is made practically useful in pharmacy, some of which will be noticed in future lectures. I will now only allude to one class of cases—that is, the production of freezing mixtures, where the production of cold, dependent upon the rapid solution of a large quantity of solid matter, is frequently attained by agitating with water a mixture of salts which are freely soluble, and which increase the solubility of one another. I shall have another word or two to say upon this matter presently in connection with the effects of solution. Returning to the subject in hand, the influence of one substance upon the solubility of another, I must briefly illustrate the reverse action to that which we have just noticed, namely, the *decreased* solubility of some salts in the presence of others.

Two or three of the most striking illustrations I can quote have occurred to me unexpectedly in my own operations.

Ordinary salt of tartar, though a very deliquescent salt, is almost insoluble in strong solution of ammonia, falling to the bottom like sand, gradually becoming moist, and after long contact forming a dense solution at the bottom, which does not mix with the lighter liquor of ammonia.

Exp. 1. —Put ℥jss. liq. am. ·880 and ʒss. salt of tartar into a 2-ounce phial, and agitate.

Exp. 2.—Put equal parts of saturated sol. carb. potash and liq. ammonia ·880 into a phial, and agitate.

So decided is the action of the carbonate in this respect, that when saturated solutions of the two salts are mixed together, sulphate is precipitated.

Exp. 1.—Add ℥j. saturated solution of carb. potash to ℥j. sat. sol. sulphate potash, and stir together; a crystalline precipitate soon deposits, consisting of KSO_4.

Exp. 2.—Sulphate of copper thrown into strongest liq. ammon. gives a pale blue tint, very little of the copper being dissolved; add more water, and deep blue is produced.

Exp. 3.—To strong liq. ammon. add a little saturated solution of cupric ammonia sulphate, and a blue precipitate is formed, the supernatant liquor being pale blue.

These observations led me, through a long series of experiments, to various interesting results, which, however, are not important to our present subject. Some of them are recorded in the *Chemical News* of January, 1864.

The rapidity of solution does not depend entirely upon the degree of solubility, some substances being very soluble, but slowly soluble; others dissolving more rapidly, but to a smaller extent.

Persulphate of iron may be taken as an illustration of a very soluble and deliquescent salt, which, when once reduced to dryness, is only slowly redissolved.

Exp.—To a test tube half full of water add a few grains of dry persulphate of iron, and agitate; a white milky liquid results, which very slowly changes to clear yellow brown (in the course of a few hours), but which rapidly undergoes the same change on being heated to boiling point.

Arsenious acid is another well-known example. If a few grains of it are shaken up in an ounce of water and filtered off, the water remains almost uncontaminated with arsenic, though the ounce of water is capable of dissolving about 10 grains of the acid.

Whereas bitartrate of potash, which is only soluble to the extent of about 2½ grains in the ounce of water, dissolves so much more rapidly when treated in the same manner, that the water immediately becomes acid from the salt dissolved, and soon takes up nearly all it is capable of dissolving.

Exp.—Into a 2-ounce phial put ℥j. aq. and 10 gr. of arsenious acid; shake, and filter off. The filtrate tested with cupric ammonia sulphate scarcely produces any precipitate. For comparison, have ℥j. aq. containing $\frac{1}{100}$ gr. arsenious acid, to which add some of the test.

Also—Into a 2-ounce phial put ℥j. of water and 10 gr. of cream of tartar; shake, filter, and test with diacetate of lead, which produces an abundant precipitate.

When it is required to produce a saturated solution of any material, it is important to keep in mind the degree of rapidity with which it is dissolved, and that the speed of solution decreases very much as the point of saturation is approached.

If 100 parts of water will dissolve 100 parts of a given salt, the first 50 parts will be taken up much more rapidly than the second; and if the salt has just been thrown into the water and allowed to subside, the water at the bottom of the vessel soon becomes saturated, and consequently heavy; the supernatant water will float above for a long time, getting slowly impregnated with the salt. On the other hand, if the salt be supported near the top of the water in such a manner falling from the bag, the contents of this glass becoming highly coloured before the contents of the other glass.

When it is desired to estimate the solubility of a salt by the evaporation of a perfectly saturated solution, more careful operation is necessary. In most cases it is sufficient if an excess of the salt be reduced to fine powder, triturated with the water for a quarter of an hour, and the excess separated by filtration; but in the case of arsenious acid, or other substances which dissolve very slowly, several days may be required. Another mode is to employ heat, so as to dissolve more than the water can retain, and subsequently to separate by filtration that which has deposited on cooling; but even in this case it is necessary to use a long-continued trituration to insure the separation of the excess, for many solutions formed with the aid of heat will continue to deposit crystals for a long time after they are cold. Solutions in this condition are known as supersaturated solutions. The phenomena of supersaturation have been made the subject of many interesting papers, more especially by Mr. C. Tomlinson. The well-known case of sulphate of soda gives us a familiar and useful illustration. I have already pointed out its great solubility at 92° Fahr. (33° C.); and it is well known that a solution saturated at this temperature will, under certain conditions, retain the whole of the salt in solution after it is cold, but the contact of a suitable nucleus suffices to change the solution into a mass of crystals.

Exp.—℥vj. sulphate of soda in ℥ij. of water, heated to 100° Fahr. till dissolved, filtered into a phial which has been washed with liq. potassæ, and then with distilled water; the phial being corked while the solution is hot, and then set at rest to cool, the solution does not crystallize till supplied with a nucleus.

I should scarcely leave this subject without noticing the crystallization of glycerine. We are so familiar with glycerine in its fluid state, and so rarely see it crystallized, that we are apt to forget that the commercial article is a supersaturated solution of a crystalline solid. It is very diffic to induce the crystallization without a crystal of glycerine act as a nucleus, rough substances, which usually act sat factorily as nuclei, being inactive in this case except at ve low temperatures and aided by agitation. The same remar apply with almost equal force to a dense syrupy phospho acid.

Mr. Tomlinson's theory is, that the activity of the nucle depends upon there being a greater adhesion between t nucleus and the salt than between the nucleus and t water, a point which is scarcely yet satisfactorily settled, b upon which it is unnecessary for me to enlarge at present.

LECTURE IV.

SOLUTION—*CONTINUED.*

Solution of Liquids—Difference between Solution and Mixture of Liquids—Solubility of Gases in Water—Woulf's Bottles—Effects of Pressure on Solubility of Gases—Effects of Temperature—Solution causes Changes in Temperature—Solution of Hydrated and Anhydrous Salts—Change in Temperature on Solution of Liquids and Gases.

THE phenomena of solubility among liquids are generally of a simple character, so far as they are at present known.

There are some liquids, such as alcohol, which will mix with water in all proportions; others which are soluble in water to a notable extent, but not in all proportions, such as ether; and a third class, such as oils, which when mixed with water almost entirely separate. The first class is frequently regarded as a case of simple mixtures, the term solution being applied only to those cases where there is a limit to the quantity of one liquid which another will take up, but this can scarcely be regarded as a philosophical restriction of the term. One of the distinctions between mixtures and solutions is, that gravity has the power of separating mixtures of fluids of different densities, but not solutions. We may add water to water, and regard it as a mixture of two portions of water, seeing that there is no appearance of the ordinary operations of the law of gravity being interfered with; but when water is added to alcohol, and gravity ceases to have the power of drawing the heavier liquid to the bottom of the vessel, we must acknowledge that there is something more than a mere mixture, and we appropriately say that the two liquids are intersoluble in all proportions. We have many examples of those variou degrees of solubility among liquids in the daily operations o pharmacy—the dilution of alcohol and the fluid acids bein of the first class; the preparation of spirit of chlorofor and of mustard liniment being of the second—chloroform bein very soluble in rectified spirit, yet not soluble in all proportions, and the castor oil contained in mustard liniment bein soluble in all proportions in absolute alcohol, soluble to considerable extent in rectified spirit, and to a smaller exten in weaker spirit. Bodies in the fluid state are most favourably circumstanced for exerting their affinities for one another consequently solutions are generally instantly produced whe soluble liquids are mixed together.

Heat in many cases increases the solubility of one liqui in another, as in the case of castor oil and rectified spirit, o chloroform and spirit; for it must be observed that thoug chloroform is very soluble in rectified spirit, spirit is not ver soluble in chloroform; 5 per cent. of spirit will not dissolv in cold chloroform, though it dissolves a little below its boiling point, and separates again to some extent on cooling 50 measures of castor oil mixed with 50 measures of rectifie spirit do not form a complete solution at 60° Fahr. (= 15·5° C.)

The solubility of essential oils in water appears to be increased by distilling the two together, but it is not unlikely that there is some difference in the quality or composition of the oil dissolved by distillation from the material yielding it, and that dissolved by agitating with water the oil which had been obtained by a previous distillation. The odour of the waters obtained by agitating the oils of cinnamon, rose, or orange flower with distilled water, is not the same as that of the water obtained by the usual process of distillation.

A few drops of oil of peppermint agitated with an ounce of water, and strained through tow to remove the larger globules of undissolved oil, leave a milky-looking water which becomes bright on the application of heat, showing the increased solubility of the oil in water at the higher temperature—a circumstance which it is well to bear in mind when we have occasion to extemporize an aromatic water.

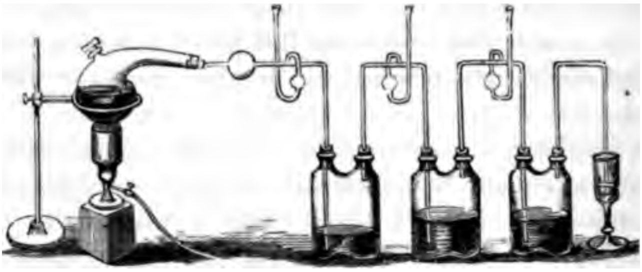
The solubility of gases in water is no less various than that of solids and liquids, and our pharmacopœial preparations afford us many examples—most notably the solutions of ammonia, nitric and hydrochloric acids.

The most condensable gases are usually the most soluble. The processes of dissolving gases are almost the reverse of those used in dissolving solids; the solvent is kept as cool as possible, and the gas is passed to the bottom of it, the supply of gas being regulated according to its solubility. The gas passing up in round bubbles exposes but a small surface to the action of the water, and from its rapid ascent it is exposed only for a very short time. Consequently, unless the solubility is extremely great, the bulk of the gas will escape unabsorbed, and to avoid this loss it is usual to employ a series of bottles arranged in such a manner that the gas which escapes absorption in the first bottle will pass in succession through the others. The gas in the first bottle is thus also subjected to a little increased pressure, which materially augments its solubility.

The following figure (Fig. 6) indicates the nature of apparatus.

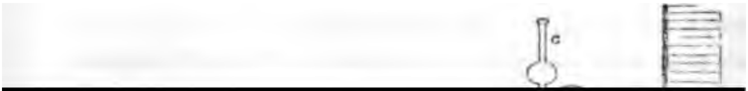
The tubes conducting the gas from the retort to the bot and from one bottle to the next, have attached to them

Fig. 6.



safety tubes, into which a little liquid is poured so as to fill the bulb. If a sudden evolution of gas takes place in

Fig. 7.



up through it, obviating the risk of the liquors being drawn back from one bottle into another, or from the bottles into the retort. In the manufacture of liquor of ammonia, large stoneware jars are used, and stoneware connecting pipes, as represented in Fig. 7.

There is another expedient in use in large manufacturing operations by which to secure the complete absorption of gases. It is known as a coke column, and is more particularly useful in absorbing hydrochloric acid when mixed with air and the products of combustion from alkali furnaces, &c. It consists of a large vertical flue filled with lumps of coke, down which water is constantly trickling. The coke being saturated with water, presents to the gases an immense surface of a highly absorptive character; the gases pass in at the bottom, and as they ascend are at every step brought in contact with water less and less impregnated with acid, till they escape from the top with scarcely a trace of acid unabsorbed. This process is called scrubbing, and the coke column is called a scrubber.

Passing a soluble gas through water at a given temperature and pressure, a definite strength of solution will be ultimately obtained; but if another gas be then passed through at the same pressure and temperature, part of the gas first absorbed will be given out again; and if a mixture of gases be passed through the water, it does not become so completely saturated with either of them as when one only is present. This is a fact to be kept in mind in preparing solution of sulphurous acid. The pharmacopœial formula yields both sulphurous and carbonic acid gases; the latter gas interferes with the complete saturation of the water; a stronger solution is more readily obtained by evolving pure sulphurous acid from sulphuric acid and copper, or any of the other well-known methods.

Practically speaking, a gas subjected to double pressure is reduced to half its original volume. This is not absolutely true of all gases and of all pressures, but for practical purposes the bulk of a gas may be said to be in inverse proportion to the pressure. Another rule regarding the solution of gases b water is, that at a given temperature the volume of gas whic water is capable of dissolving remains the same, to whateve pressure it may be subjected.

For example, 100 cubic inches of water at ordinary atmospheric temperature and pressure will dissolve 100 cubic inche of carbonic acid, weighing 47·3 grs., but under a pressure of tw atmospheres, 47 grs. of carbonic acid only measure 50 cubi inches; or, in other words, it will require 94 grs. of carboni acid to measure 100 cubic inches; and, according to the rul just given, it will require 94 grs. to saturate 100 cubic inche of water under a pressure of two atmospheres. But unde greatly increased pressures this rule ceases to be strictl applicable; thus it is said by Courbe, that under a pressur of seven atmospheres only 500 cubic inches are dissolved and it is well known, that when the pressure is increased til the carbonic acid liquefies, the fluid acid is not dissolved freel by the water. It is said, indeed, that under these circumstances the acid is only "slightly soluble in water;" but th difficulty of experimenting with fluids under these very hig pressures probably prevents our information being reliabl accurate upon this subject.

Exp.—Ice water becomes milky on the addition of subacetate of lead;[*] good recently distilled water less so. The same water boiled a minute gives a very slight haziness, and sample boiled a quarter of an hour gives none.

Under the same pressure, water will dissolve 727 times its olume of ammonia at 15° C., or 1049 times its volume at 0° C.[†]

Carbonic acid dissolves more freely in alcohol than in water; ammonia dissolves less freely in alcohol than in water; gases, like solids and liquids, have their peculiar solvents, as well as particular conditions, which facilitate their solution.

We may also note, in passing, that the experiment previously quoted, in which carbonate of potash was found to be sparingly soluble in solution of ammonia, also showed that ammonia was less soluble in water which held in solution a large proportion of carbonate of potash, and now we add fused potash to strong liquor of ammonia (as the former is dissolved the ammonia is expelled), which is a convenient way of obtaining ammoniacal gas for experimental purposes. To illustrate another point or two, we pass the ammonia as it is evolved through two U tubes, the first being dry, and the second charged with small fragments of wet pumice stone. You will observe that the dry tube is not heated by the passage of the ammonia, but the first limb of the next tube becomes warm from the rapid liquefaction of the gas. The second limb of the second tube is not heated at all, and no ammonia escapes from the open end, showing how thoroughly efficient a "wet scrubber" is as a means of absorbing a gas, the whole of the ammonia being absorbed by the first three inches of wet pumice.

A notable effect of solution is change of temperature. Solids in dissolving generally lower the temperature, the heat which disappears being consumed in their conversion from the solid to the liquid state. Gases, on the other hand, as we have just seen, when they become dissolved, part with the heat which was essential to their gaseous condition, and the resulting solution is warmer than the mean temperature of the gas and water before the solution took place. As a further experiment, which you may at any moment try for yourselves, a wet bulb thermometer placed in the neck of an ammonia bottle indicates a rise in temperature, from the ammonia condensing in the moisture which surrounds the bulb, and giving out its latent heat.

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[*] Lime water is not a sufficiently delicate test for carbonic acid to be used for this experiment, carbonate of lime being more soluble in the presence of the hydrate.

[†] Bunsen, in "Dic. Sol."

The solution of gases we have just noticed is promoted by reduction of temperature, and it will be readily seen that a larger quantity of heat being essential to a body in the gaseous than in the liquid condition, these two phenomena—the increased solubility at low temperatures, and evolution of heat on the rapid solution of a gas—become readily explicable; the molecular motion, which constitutes gaseous elasticity and mobility, taking the form of sensible heat when the extreme elasticity and mobility, which are characteristic of a gas, become changed for the much smaller degree of these properties which belongs to liquids.

Solids, on the other hand, having less molecular motion than liquids, the conversion of the former into the latter necessarily requires the conversion of the motion of heat into the water on an anhydrous salt must not be looked upon as a solution of the anhydrous salt, but of the crystalline hydrate, the heat evolved by the chemical union of the anhydrous salt with the water of crystallization being, in some cases, of greater amount than the heat absorbed by the conversion of the crystallized salt into a solution.

This is a fact which must be remembered in the production of freezing mixtures; salts will produce a greater degree of cold if used in the form of crystalline hydrates than the same salts in an anhydrous condition. For example—

		Temperature falls from
Snow* . .	4 pts.	+ 32° to - 40° = 72° Fahr.
Dry chlor. cal.	5 „	
Snow . .	2 „	+ 32° to - 50° = 82° Fahr.
Cryst. chlor. cal.	3 „	

If we mix one equivalent (80 parts) of anhydrous sulphate of copper with five equivalents (45 parts) of water, the heat produced is sufficient to cause the ebullition of the water, the pale grey colour of the anhydrous salt being changed to the well-known blue of the crystalline hydrate.

Exp. 1.—ʒiv. anhydrous sulphate of copper thrown into a test-glass containing fl. ʒiij. of water.

But if we take one part of the crystallized salt and mix it with two and a half times its weight of water (the quantity requisite for its solution), a reduction of a few degrees in temperature will take place.

Exp. 2.—℥j. fine powdered sulphate of copper; fl. ℥ijss. water, mixed in a test-glass with thermometer.

These same phenomena may be observed with many salts, but I have selected sulphate of copper for the illustration, as it affords us additional evidence that the solution of a salt which crystallizes in combination with water is to be looked upon as a solution of the *hydrate*, and not of the anhydrous salt, the blue colour of the solution corresponding with the blue hydrate, and being unlike the calcined sulphate, thus supply-

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[*] Gray's "Supplement to the Pharmacopœia," by Redwood.

ing a kind of evidence we cannot obtain with colourless salts. Had the experiment been performed with sulphate of soda, the phenomena would have been similar, with the exception that, being a colourless salt, we should have lost the benefit of the colour indication, and should have had to depend solely upon the difference of force with which the salt holds the two portions of water for evidence that the solution is a solution of the crystalline hydrate, the water of solution evaporating with almost the facility of pure water (excepting concentrated solutions, especially of deliquescent bodies), leaving the salt in combination with water of crystallization, which requires a higher temperature for its separation.

The temperature resulting from the dissolving of the anhydrous salt is probably determined by the relation between the affinity of the salt for the water of hydration and its affinity for the water of solution, and the proportion in weight which the salt bears to these two portions of water.

As a further experiment, we take three portions of sulphate of soda, the first with its ordinary water of crystallization weighing 2 oz., the second dried at 212° till it has sulphuric acid in acids of various densities,* you will find evidence of the condensation which takes place on mixing the strong acid with water; thus—

100 vols. of acid will weigh 184; to this add half its weight of water, *i.e.*, 92 parts, and the volume of the mixture, if no contraction took place, would be 192, and its weight (184 + 92 =) 276, and we should find as its bulk (192) is to its weight (276), so is 100 to its sp. gr. 142; but by reference to the table we find the actual density of an acid of this strength (66 per cent. of H_2SO_4) is 1·55. Or, to reverse the calculation, the sp. gr. of an acid of this percentage being 155, this number is to 100 as the weight of the mixture (276) is to its volume, in which way we find its volume to be 178, instead of 192. It has thus contracted rather more than 7 per cent. of its volume.

For experiment, we mix fl. ℥j. of water with fl. ℥ij. of oil of vitriol in a small flask, and put a test-tube with ʒj. of water into the mixture; the water shortly begins to boil.

Solutions of gases do not appear to obey a general rule as regards their density.

1. Solution of sulphurous acid is heavier than water, the liquid acid also being heavier.

2. Solution of ammonia is lighter than water, the anhydrous liquid ammonia being also lighter.

3. Solution of carbonic acid is heavier than water, though the liquid acid is lighter.

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* DENSITY OF SULPHURIC ACID OF DIFFERENT STRENGTHS.

Sp. Gr.		Per cent. of H_2SO_4.	Sp. Gr.		Per cent. of H_2SO_4.
1·8485	=	100	1·4860	=	60
1·8430	=	96·8	1·3884	=	50
1·8290	=	93	1·2999	=	40
1·8155	=	90	1·2184	=	30
1·7120	=	80	1·1410	=	20
1·5975	=	70	1·0682	=	10
1·5503	=	66	1·0074	=	1

More complete tables will be found in Attfield's "Chemistry," Gmelin's "Handbook," Storer's "Dictionary of Solubilities," &c.

QUESTIONS FOR EXAMINATION ON SOLUTION.

What is solution?

What is the difference between dissolving zinc in diluted sulphuric acid, and dissolving oxide or sulphate of zinc in the same?

Name some of the salts most soluble and least soluble in water.

What effect has the presence of one salt upon the solubility of another?

Give examples.

What other circumstances have a great influence upon solubility?

When a substance is said to be very soluble, in what liquid do we understand that it will dissolve?

Does its solubility in water indicate its solubility in other liquids?

Is there any rule by which it can be predicted of a given compound whether it will be found soluble or not?

What is the general effect upon temperature caused by solution?

the solubility of most solids. Cold and pressure increase the solubility of gases. When solubility is spoken of, it is understood to be in relation to water unless otherwise indicated; solubility in water, however, is no guide to the solubility of the same body in other solvents. Bodies having analogous constitutions, and little chemical affinity, are usually most disposed to form simple solutions; but no clear rule has yet been discovered by which to connect a body with its solvents. Simple solution of solids is usually accompanied by a fall in temperature; solution of gases causes a rise in temperature. When a solvent retains more of the soluble matter than it could under the then existing circumstances dissolve, it is said to be supersaturated.

LECTURE V.

CRYSTALLIZATION.

Crystalline and Amorphous Matter—Mother Liquor—Evaporation till Pellicle is formed—Separation of Heteromorphous Salts—Size of Crystals—Water of Crystallization—Nuclei.

When solutions are evaporated, or cooled, so much that the solvent is no longer capable of retaining the whole of the solid matter in solution, the latter is deposited in one of several distinct conditions. It may be that there is a glass-like residue, which is homogeneous and devoid of any characteristic form, as is the case with gum, gelatine, citrate of iron and ammonia, &c.; or the residue may have a pulverulent condition, as is the case with persulphate of iron (ferric sulphate), in which there are no distinct forms visible, but at than to pharmacy; but there are several points to which it is desirable to draw your attention.

In most cases, when it is desired to obtain crystals, we avail ourselves of the difference in solubility occasioned by changes of temperature; a salt which is more soluble at a high temperature, being dissolved to its greatest extent in hot water or other solvent, deposits the excess in the form of crystals on cooling.

SOLUBILITY OF SULPHATE OF COPPER.

100 of Aq. at	$CuOSO_3,5$ Aq	100 of Aq. at	$CuOSO_3,5$ Aq.
0° C. dissolves	31·6	60° C. dissolves	77·3
10° „	36·9	80° „	118·0
20° „	42·3	100° „	203·3
40° „	56·9		

If we have the salt originally in a solid state, but not crystallized, we may add to hot water as much of the salt as will dissolve, then on allowing it to cool we obtain a crop of crystals. The solution which has deposited them is called the mother liquor. This, on heating, may again be made to dissolve a fresh portion of the salt, which in its turn will be deposited as crystals on the solution again becoming cool. In this way the original salt may be taken up, portion by portion, till the whole is converted into crystals. But cases of this kind, where the sole object is to convert a mass of uncrystallized salt into crystals, are not of very frequent occurrence. It more commonly happens that a salt in process of manufacture is obtained in the form of solution, or is to be separated from some insoluble matter by being dissolved; and in this case the process preliminary to crystallization is to reduce the quantity of water by evaporation, or boiling down, till the salt begins to separate in the form of a thin shell or pellicle on the surface. It may then be set aside to crystallize, and the mother liquor, which is subsequently drained off, will, on a further evaporation in the same manner, produce a second crop of crystals. In operating with salts which do not vary much in solubility with change of temperature, other methods must be adopted. Sea salt, for example, which is almost as soluble in cold water as in hot, is obtained in large crystals by the continued evaporation of sea water at ordinary temperatures, or is obtained in small crystals fit for table use by boiling off the water with constant stirring, and raking up the deposited crystals from the bottom of the pan. In these three cases which I have selected to illustrate crystallization in its simplest character, the salt has not been supposed to undergo any change beyond being brought into the crystalline state ; but crystallization is usually had recourse to as a means to some other end. Bodies which are not capable of crystallizing are less confidently regarded as of definite composition, and bodies which are capable of crystallizing lose one important evidence of purity if not obtained in this condition.

Certain groups of salts will crystallize in similar forms ; thus the group of potassium salts, chloride, bromide, iodide, and fluoride, are of the cubic form. The group of alums, common alum, iron alum, chrome alum, whether they be compounds of ammonia or potash, crystallize in octahedra. These are called isomorphous groups, the meaning of the word being "of the same shape," but, as generally used, it is intended to express a similar chemical constitution, as well as a similar shape of crystal.

Dissolve with heat, set aside in a beaker containing a slip of wood; as it cools crystals deposit upon the wood, which may be washed with a little cold water and tested. They contain iron and alumina, but not copper.

The mother liquor, evaporated to a small bulk and cooled, deposits crystals of two kinds—sulphate of copper, containing traces of iron and alumina, and crystals of alum, containing abundance of iron, but only traces of copper.

Crystallization thus becomes an important means of separating salts of one group from those belonging to other groups, though it is not nearly so advantageous in separating from one another salts belonging to the same group. Supposing alum to be crystallized from a solution containing sulphate of copper, the crystals may contain a small percentage of the copper, the great bulk of it remaining in the mother liquor; the crystals being again dissolved and crystallized, the second crop will contain still less of the copper, the second mother liquor having retained the greatest part of what escaped the first—a second crystallization frequently being sufficient to convert a crude commercial salt into one of sufficient purity for medicinal use, and a further repetition of the process will remove every trace of impurity.

The size and regularity in shape of crystals are increased by a very slow deposition; consequently, when these points are aimed at, the cooling of the solution must be very gradual, or spontaneous evaporation must be had recourse to, and agitation avoided. If, on the other hand, it is desired to have the salt crystallized in a granular or sandy condition, rapid cooling with agitation, or rapid evaporation with ebullition, is most successful.

It is frequently observed that salts crystallize with different proportions of water according to the circumstances attending their crystallization. Thus ordinary carbonate of soda, in the usual course of manufacture, crystallizes with ten equivalents of water; but if the liquor from which crystals are to be obtained be completely saturated at the boiling point, the salt is found to contain only eight equivalents of water. Then again, if solution of proto-sulphide of sodium be exposed to the air, carbonic acid is absorbed, and a carbonate of soda crystallizes out, containing six equivalents of water; a carbonate with five equivalents of water is obtained in crystals deposited from the ordinary carbonate fused in its water of crystallization, and a little variation in the temperature and method of operating will yield a fifth hydrate containing only one equivalent of water of crystallization.*

Sulphate of soda usually has ten equivalents of water, but it will also crystallize with eight equivalents, and even without any water at all. Proto-sulphate of iron usually has seven equivalents of water, but crystals may be obtained with four, three, or two equivalents.

Subjoined is a table showing the water of crystallization in several common pharmaceutical salts.

WATER OF CRYSTALLIZATION.

Al_2O_3	$3 \cdot SO_3$	KO, SO_3	24 Aq. % 45·5
52	120	47 40	216 = 475
CuO	SO_3	5 Aq. % 36	
40	40	45 = 125	

lization will commence; it may then begin without any evident cause, and go on rapidly to completion, or it may go on very slowly. It will frequently happen in large manufacturing operations that the growth of the crystals will continue for several days, or even several weeks, according to the nature of the salt, the size of the vat, the temperature of the season, &c.

The commencement of crystallization is facilitated by the presence of rough foreign bodies, or particles of crystallized salt at the time when crystallization ought to commence, and the completion of the process is expedited by increasing the surface upon which crystals can be deposited. This is sometimes accomplished by suspending twigs or strings in the solution. Crystallization may sometimes be set going by friction, as in rubbing a stirring-rod upon the side of a beaker of liquor, the crystals depositing in lines which the rod has traced upon the glass.

A crushed salt, or a quantity of salt consisting of small and large crystals, mixed with a small quantity of solvent, will, after a lapse of time, become considerably changed, the small particles gradually disappearing, while the large masses increase in size. This takes place more rapidly with frequent variations in temperature. As the heat increases, the small particles dissolve more in proportion than the large, but as it cools again, the large grow at least as quickly as the small. It is probable that the result is also influenced by other causes, which, however, have not yet been sufficiently investigated. The phenomenon will be sometimes observed in dispensing a mixture containing more of some powdered salt than it is capable of dissolving, the salt, though finely rubbed when the mixture is made, becoming rough and knotted if the mixture is long kept.

LECTURE VI.

PRECIPITATION, Etc.

Crystalline Precipitates—Pulverulent Precipitates—Circumstances modifying Condition—Washing Crystals—Centrifugal Drier—Drying b Evaporation—Water of Decrepitation—Washing of Precipitates, b Decantation, by Filtration—Drying by Pressure and Evaporation.

Crystallization is sometimes produced by the mixture o two solutions of freely soluble salts, where decompositio results with the production of a salt which is not soluble enoug to remain in solution, but is yet far removed from absolut insolubility. We have an instance of this kind in the formation of ammonia alum by the addition of solution of sulphat of ammonia to a solution of sulphate of alumina, the alu being deposited in octahedra of a palpable size, becaus [redacted] agglomeration, and to sulphate of baryta or chloride of mercury, in which we lose all trace of their being other than amorphous and impalpable powders. But though the minuteness of the particles of which a precipitate is composed will depend in great measure upon its composition, it is quite possible to influence the mechanical condition in which a given chemical may be deposited. The more gradually a precipitate is thrown down, the more crystalline it will generally be found; but even after deposition, long-continued contact with the mother liquor may cause its change to a more granular or crystalline condition, and this generally takes place in a still more marked degree with the application of heat, especially with active ebullition.

When the physical condition of precipitates is in other respects unimportant, the granular state is preferred as facilitating their separation from the mother liquor, and their purification by washing.

The presence of foreign salts, which do not evidently increase the solubility, will sometimes augment the magnitude of the particles. I have obtained carbonate of magnesia, for example, as a heavy precipitate, almost sandy in texture, by adding a little carbonate of soda to a saturated solution of common table salt, which, as usual, contained chloride of magnesium as an impurity.

The washing of crystals, which is sometimes necessary to remove the mother liquor and any impurities it may contain, must be performed with as little water as possible, to avoid loss of the salt; and before commencing, any clumps of crystals should be broken up, and the salt drained in a funnel till no more mother liquor drops out; then small successive portions of cold water poured upon the top, and allowed to drain between each addition, till it is found that the washings come away nearly free from the impurity which they are designed to remove. The appearance of the crystals is injured a little by this treatment, from the water dissolving off the sharp edges; and if it is desired to avoid this, the crystals may be washed with a cold saturated solution of the salt under treatment. It is not often practicable to use pressure to remove the mother liquor, except in such cases as the crystallization of crude hydrochlorate of morphia or aloin in process of manufacture; the mother liquors in these instances, being syrupy, are removed from the crystals by pressure in a cloth, the appearance of the semi-crystalline cake so obtained being a matter of no moment, as it is to be redissolved and again crystallized; but in many manufacturing processes, where the appearance of the product is a matter worthy of consideration, the removal of the mother liquor by means of centrifugal force may be adopted with the greatest advantage. In refining sugar, for example, the crystals of moist sugar are deposited in treacle, a fluid so viscid that subsidence and draining cannot be used for their separation; and the crystals being exceedingly soluble, washing is out of the question. The semi-fluid mass of treacle and sugar is thrown into an iron drum with perforated sides, which is made to revolve on its axis with great velocity, by which means the treacle flies off on all sides, leaving the sugar only slightly moist. The same mode has recently been adopted for drying Epsom salts, and after this treatment they are said to retain only from ½ per cent. to 1 per cent. of mechanically attached water, a quantity so small as to obviate any

The appliances described as used for drying herbs, &c., in a former lecture, may be used for drying crystallized salts; but the operation is one of considerable nicety, the precise degree of heat, &c., requiring adjustment to suit the properties of each salt; some, which contain much water of crystallization, are apt to undergo aqueous fusion, with a slight elevation of temperature. This is the case with crystallized carbonate of soda; the bicarbonate, on the other hand, is apt to lose part of its carbonic acid. If it is desired to retain the crystalline condition of efflorescent salts, they must be dried at a low temperature, and removed from the drying trays as soon as a sufficient degree of dryness has been reached; but if it is desired to remove their water of crystallization, the temperature, low at first, may be gradually raised, taking care that it never rises so high as to cause fusion. Deliquescent salts should also be dried with a gradually raised heat, to avoid their solution at a high temperature in the water, which was only mechanically adhering at a low one. A large number of salts are called permanent, being neither efflorescent nor deliquescent, and may be dried with less difficulty. A fourth class, such as the chlorides, iodides, and bromides of potassium, &c., have no water of crystallization, but water mechanically confined between the plates of which the crystal consists; the water thus confined does not evaporate; but if a strong heat be applied, the crystals burst open from the steam generated. It is consequently called water of decrepitation; and to obtain the salt free from it, the crystals should be roughly powdered before drying. They will then dry without difficulty, and are not liable to injury by any ordinary heat.

Turning our attention now to the treatment of precipitates, we find the difference in their properties from those of crystallized salts is one rather of degree than of kind. They are in particles of a smaller size; they are all soluble, but to a much smaller extent; they less commonly contain water of crystallization, but frequently water of hydration, and generally much more water mechanically attached; and the salts contained in the mother liquor from which they have been thrown down will frequently adhere with considerable pertinacity. These facts determine the mode of treatment applicable to them.

Before proceeding to the washing and drying of precipitates, we must briefly note that precipitates will sometimes vary, either in mechanical condition or chemical composition, from very trifling variations in the mode of operating. The results will differ according as the solutions are hot or cold, concentrated or dilute, neutral or otherwise, and even according to which solution is poured into the other.

In illustration of these points, I may quote the precipitation of iodide of lead from its acetate by iodide of potassium, as described in Gmelin's "Handbook of Chemistry."

When strong and cold solutions of iodide of potassium and acetate of lead are mixed, pulverulent iodide of lead is precipitated. If the solutions are hot, or considerably diluted, the iodide is deposited in thin yellow laminar crystals. If the lead solution be poured into the iodide, the lead salt never being in excess, a pure iodide of lead is precipitated. If the iodide be poured into the lead solution, the lead is necessarily in excess at first, and an immediate precipitate of oxyiodide of lead is deposited. If the iodide of potassium solution be slightly acidulated with acetic acid, and dilute solution of liquor from which it has been thrown down; water is poured upon it, agitation, subsidence, and decantation being repeated till the washings contain only an unimportant quantity of the impurity. In this process the most important points to be noted are, that the precipitate must be thoroughly agitated with each successive portion of water; that the more completely subsidence and decantation are effected the sooner the precipitate will be clean; that a precipitate frequently contracts considerably in bulk as it becomes clean; that hot water allows subsidence to take place more rapidly; that it acts as a more powerful solvent of the matter to be washed away; that it promotes the aggregation of the precipitate; and, whenever it is admissible, effects the washing more quickly and satisfactorily than cold. The water may be decanted either by simply tilting the vessel, or by the use of a syphon. In the former case, for small operations it is convenient to grease the rim, and use a guiding rod to convey away the liquor, and prevent its running down the side of the vessel. The guiding rod is most suitably of glass, and is to be held in a vertical position against the greased rim, just in advance of the liquor which is about to be decanted. As the liquor is poured out, it will then run down the rod instead of dribbling down the side of the vessel, and is readily guided into any receptacle without loss. Washing by decantation is most suitable for precipitates which settle rapidly, and are of small bulk. Light and bulky precipitates are apt to flow over with the washing liquors, and in any case it is a prudent precaution to pour the washings through a filter, upon which the precipitate itself may subsequently be collected and drained. The second method of washing is by filtration, which is suited for precipitates which are light, bulky, and do not settle well. In operations on the smallest scale, the most suitable arrangement is the ordinary paper filter; and though this must be familiar to you all, there are one or two points to which it is desirable to draw your attention. The paper should be so folded as to fit the funnel nicely. The paper being folded in half, first in one direction, and then in the other, and opened out into the shape of a funnel, wi folded accurately, always have exactly the same angle; b funnels vary a little, it will sometimes be found that the p fits tightly into the throat of the funnel, and is loose abou top. This retards filtration, and risks the rupture of the p to avoid which, when the funnel is found to require it, second fold of the filter paper should be made not exactl right angles with the first; the paper may then be opene either a more obtuse or more acute angle as required, an adjusted as to suit any funnel that may be in use. I p to have the paper *slightly* more obtuse than the funnel. paper having been adjusted, should be wetted before precipitate is put upon it; this, causing the fibre of the p to swell, prevents the precipitate from passing through, also prevents the paper from becoming choked, as it woul if the pores were first filled with the precipitate, and contracted by the swelling of the fibre. The wetting of paper thus promotes both clear and rapid filtration. In mode of washing, as in the last, it is desirable to use hot w whenever admissible; the rate at which it passes throug filter is in a very notable degree more rapid; and m precipitates which pass through the paper, if filtered fro of a four-legged stool inverted, the cloth being fastened by its four corners with strings to the parts representing the feet of the stool. Calico being more open in texture than paper, most precipitates will pass through it more or less at the commencement of the filtration; but if the turbid filtrate be returned to the filter to avoid the loss of precipitate until the filtrate comes through bright, the washing may be continued without further difficulty. A precipitate having been left at rest upon the filter till no more filtrate drains out, is still imperfectly drained; but the dropping will begin again if it be gently shaken by striking the side of the funnel or filter bag; and when it ceases to give up water in this way, a further portion may be extracted by pressure. The paper filter may be taken out of the funnel, and carefully opened out flat upon a cloth, or a second sheet of filtering paper. The filter having been entirely unfolded, the precipitate will be found upon one half of the paper, and the other half may be folded over to cover it, while a dry paper or cloth is laid upon the whole, and gentle pressure employed to extract the water. It is desirable that the pressure be very gentle at first, or the paper will almost certainly burst; but as the water is expelled, the precipitate becomes so firm that the pressure may be increased to any extent, changing the outside paper or cloth till the precipitate is almost dry. To complete the desiccation, recourse may be had to the ordinary drying closet or hot-plate. The porous red-ware saucers used for putting under gardener's flower pots are convenient for drying precipitates in, as their porous nature permits the absorption of moisture and its evaporation from the whole surface of the saucer; but as the porous ware is difficult to clean, a saucer having been used for one material should not be used for another.

QUESTIONS FOR EXAMINATION ON CRYSTALLIZATION AND PRECIPITATION.

What are the usual modes by which a soluble salt is obtained in the crystalline state?

What are the objects sought to be obtained by crystalliz tion?

What substances are most readily separated from o another by this process?

What circumstances influence the size of crystals?

What is the difference between water of crystallization an water of decrepitation?

How are crystallized salts to be dried?

What is the difference between crystallization and precipitation?

What difference is there in the modes of washing precipitate and crystals?

RECAPITULATION OF CRYSTALLIZATION AND PRECIPITATION.

Soluble salts are usually crystallized by cooling a hot saturated solution or by evaporating the solvent, the object of the process being to obtain them free from foreign salts, and of a definite degree of hydration. Isomorphous substances are not separated by this means so readily as heteromorphous.

Crystals which are deposited slowly, and without agitation, are usually largest and most regular. Most salts crystallize in combination with water in one or several definite proportions; those which have no water of crystallization frequently have water mechanically held, and known as water of decrepitation.

LECTURE VII.

DIFFUSION IN LIQUIDS, DIALYSIS, OSMOSIS, ETC.

Diffusion—Crystalloids—Colloids—Rate of Diffusion—Dialysis—Osmosis—Hydration and Dehydration of Colloids—Infusion of Gentian, &c.—Diffusion Groups—Times of Equal Diffusion—Influence of Heat.

THOUGH the process of dialysis is not made use of in the preparation of any officinal product, the natural laws upon which that process depends are called into operation in so great a number of cases that some account of them cannot fail to be both interesting and useful.

In treating of solution, I stated that when a body is dissolved, no matter what its density may be, it ceases to be separable from the solvent by the action of gravity; and the first point to be noted now is that the dissolved bodies not only will not subside, but that, if a dense solution be placed at the bottom of a vessel, and some of the solvent be poured upon it, the dissolved matter will gradually diffuse upwards against the action of gravity till the whole liquor is uniform. And this gradual mixing cannot be looked upon as accidental, as the consequence of currents in the fluids, change of temperature, &c., for careful experiments have shown that bodies differ in the rate at which they diffuse in this manner. A simple experiment will show this. I take two tall glass jars, one filled with pure water, the other with water coloured blue with litmus. Into the pure water is poured ½ oz. of caramel solution with the aid of a long tube funnel, so that it may be carried to the bottom of the water, where it will remain as a layer of deep-coloured fluid, showing very little tendency t rise. Into the blue water is poured, in the same manne ½ oz. hydrochloric acid, of the same density as the carame and mixed with gum to give it the same viscosity. The acid however, diffuses into the blue solution at a very palpabl rate, as may be seen by the change in colour which gradually takes place from the bottom upwards. In this experiment we have one of the most diffusible bodies contrasted with a body at the opposite end of the scale, and between these there is every diversity in the diffusion rates of soluble substances.

We are indebted to Professor Graham for a careful investigation of this subject. It is unnecessary for us to follow the details of his experiments, but we may with advantage note various of the results.

1. Crystallizable substances, as a class, diffuse more rapidly than those which solidify in the gelatinous condition.

2. Crystalline salts differ much among themselves in the rate at which they diffuse; but salts having the same crystalline form and chemical constitution diffuse at about the same rate.

3. The rate of diffusion is proportionate to the strength of the solution used, and increases with a rise in tem-

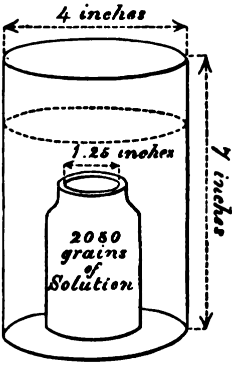
soluble matters diffuse in water under the same circu stances:—

100 parts of water and 20 parts of	Diffused in 8 days grains.
Chloride of sodium	58·6
Nitrate of soda	51·5
Treacle	32·5
Sulphate of magnesia	27·4
Sugar	26·7
Gum arabic	13·2
Albumen	3·0

These numbers, you will observe, give comparative rather than absolute results, but are equally instructive and reliable, as the same vessels, the same temperature and strength of solution were observed throughout.

The mode of operating is as follows:—The solution to be examined is placed in the inner jar, indicated in Fig. 8, which it completely fills; distilled water is then poured into the outer jar till it is filled up to the dotted line, every care being taken to avoid disturbing the contents of the small jar, the whole being guarded against agitation or changes of temperature during the experiment. At the end of the required time the contents of the large jar may be removed with a syphon and evaporated to dryness, together with a further portion of distilled water with which the outside of the small jar and the inside of the large one have been washed.

Fig. 8.



The weight of the residue thus obtained gives the diffusion rate of the body under experiment, compared to that of any ther substance operated upon in the same way.

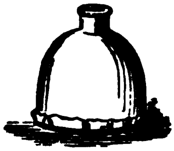
Vegetable tissues and animal membranes, which have the wer of absorbing water freely, permit the diffusion of crys-lloids to go on through their substance with very little ob- uction; but they offer so much resistance to the passage of colloids that they may be considered virtually impervious to them. If a solution containing both colloid and crystalloid matter be placed in a bladder, and the bladder immersed in water, it will shortly be found that the crystalloid matter is passing through the bladder into the water, and that the colloids will remain behind; thus a species of analysis, called dialysis, may be conducted by the different diffusibilities of the two classes of substances through the bladder. The following table, from Watt's "Dictionary of Chemistry," gives the comparative rate at which dialysis takes place with divers soluble substances:—

RATE OF DIALYSIS.

Dialyser containing 98 grams water and 2 grams of	Weight in grams diffused in 24 hours.	Dialyser containing 98 grams water and 2 grams of	Weight in grams diffused in 24 hours.
Chloride sodium .	1·657	Extr. logwood . .	·280
Picric acid . .	1·690	Catechu . . .	·265
Ammonia . . .	1·404	Extr. cochineal. .	·086
Theine . . .	1·166	Gallo-tannic acid .	·050
Salicin . . .	·835	Extr. of litmus .	·033
Cane sugar . .	·783	Pure caramel . .	·009
Amygdalin . .	·517		

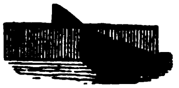
Results of this kind are obtained by placing the solution to be experimented upon in a dialyser consisting of a wide-mouthed bottle, the bottom of which is removed and replaced by a bladder or sheet of parchment-paper, carefully selected, parilla mixture, and after the lapse of a short time test the dialysate, and readily detect the presence of iodide of potassium, which has come through freely, while the dark-coloured vegetable extractive matters, which in the original mixture prevented the application of the test, have been kept back by the diaphragm.

Fig. 9.



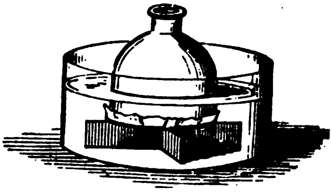
The Glass Dialyser.

Fig. 10.



Support of Gutta-Percha.

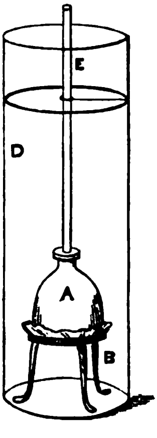
Fig. 11.



The whole in action.

Dialytic action has, no doubt, a very important influence upon the vital functions of animals and vegetables, and promises to reward investigators with new light on these subjects; it is not, however, in that connection that I wish to draw your attention to it, but in relation to the solution of various matters in the preparation of infusions, decoctions, &c. But before doing so, I must prepare my ground more completely by describing a third class of phenomena connected with diffusion.

Fig. 12.



If a bladder be filled with a saturated solution of carbonate of potash, while a portion of the salt is passing out, a quantity of water much in excess of the salt passes into it, so that the bladder, if full at first, may be burst by the inflow of the water.

This passage of the fluid through the bladder is called osmosis, and is distinguished as endosmosis when the water passes into the solution more rapidly than the latter passes out, and exosmosis if the outward flow preponderates.

The osmometer (Fig. 12) is an arrangement of apparatus very similar to the dialyser. The solution to be examined is placed in the vessel A, supported upon a tripod B, placed in the jar of water D. At the commencement of the experiment, the level of the water in D is made to correspond exactly with the level of the solution in the tube E. After the necessary interval, a rise in the liquid in E indicates endosmosis, or a fall indicates exosmosis. Like dialysis, the rate at which osmosis takes place can only be stated in a table indicating the results obtained in some particular course of experiments. Slight differences in the membrane would vitiate the results if different instruments were used.

In the following table, from Watt's "Dictionary of Chemistry," we have the comparison of a series of solutions, all containing 1 per cent. of solid in water, except hydrochloric acid, which contains 0·1 per cent. of HCl.

OSMOSIS OF 1 PER CENT. SOLUTIONS.

Oxalic acid	–	148	Chloride of calcium	+	20
Hydrochloric acid (0·1 %)	–	92	„ zinc	+	54
Chloride of gold	–	54	Nitrate of lead	+	120
„ platinum	–	30	„ copper	+	200
„ magnesium	–	3	Chloride of copper	+	351
„ sodium	+	2	„ iron	+	435
„ potassium	+	18	„ aluminium	+	540

The mark – indicates the outward flow; the + mark indicates that the predominating flow was from the water into the solution.

of dryness proportionate to the relation which subsists between the affinity of the spirit and the gelatine for water, and the proportion of the three bodies present. This experiment, you will notice, is closely parallel to those which I used in illustration of evaporation, and the relation which subsists between the moisture of the atmosphere and of the materials exposed to it. We might almost say that the water in the gelatine had evaporated into the atmosphere of alcohol in which it has been immersed.

Our materia medica affords us numerous examples of substances which are insoluble or imperfectly soluble colloids; and our pharmaceutical operations supply equally numerous cases where these materials are exposed to the action of water, spirit, or both in succession. The subject is one well worthy of study, and no doubt an experimental investigation of the phenomena would yield a harvest of suggestive results.

I can at present only indicate the bearing of these phenomena upon such simple processes as the preparation of infusions.

Another force—capillary attraction—with which you are probably sufficiently familiar, also plays an important part in the passage of liquids into the substance of drugs submitted to their action; and now, supposing the ingredients for infusion of gentian to be placed in a jar and covered with hot water, capillary attraction comes into play to saturate the root with moisture, the soluble portion becomes dissolved, the cells and their contents then are subject to the action of dialysis and osmosis, the cells themselves becoming distended, and their contents being diffused more or less rapidly according to whether they are colloid or crystalloid in their nature; the mucilaginous principles being slowest in diffusing, and the alkaloids and acids more rapid.

Several of the mucilaginous principles, such as pectin and bassorin, undergo very imperfect solution; and if it is desired to extract them, the vegetables containing them must either be thoroughly comminuted in the first place, and i agitated during infusion, or subjected to pressure after have been acted upon by the hot water, as their imp solubility and small diffusibility would otherwise pr their satisfactory extraction. If, on the other hand, desired to avoid the solution of mucilaginous matters with crystalloids, coarse comminution should be adopted the ingredients may be suspended in the water to avoi necessity of stirring; cold water should be preferred, ar infusion drained off without pressure.

Turning again to Graham's results, his second indu that isomorphous bodies have similar diffusion rate exemplified in the following table of diffusion groups it is interesting to notice that, though the time wh required for an equal diffusion of sundry compounds not show any simple numerical relationship, if the nu expressing time be all squared a simple ratio at once be evident:—

DIFFUSION GROUPS.

	Time of Equal Diffusion.	Squares of Time.	Ratio o of T
HCl HI	3·96	15·68	

emplified in a table giving the quantity of HCl diffused at different temperatures:—

The rate of diffusion of HCl—

At 60° Fahr.	being taken at	1·00
80° „	is	1·35
100° „	„	1·77
120° „	„	2·18

Another table in Watt's "Dictionary of Chemistry" gives a comparison of the time required to diffuse equal quantities of the following substances, the time required for HCl being taken as the unit:—

	Times of Equal Diffusion.
Hydrochloric acid	1·00
Chloride of sodium	2·33
Sugar	7·00
Sulphate of magnesia	7·00
Albumen	49·00
Caramel	98·00

The numbers given in one table do not exactly agree with those given in others, but I think we may set that down to comparative newness of the subject, and the tedious nature of the experiments. It is difficult to insure the perfect similarity of the results, when the circumstances are varied between one series of experiments and another, but we need not discredit the accuracy of the comparison between parts of the same table.

QUESTIONS FOR EXAMINATION IN LIQUID DIFFUSION AND DIALYSIS.

Define the terms crystalloid and colloid.

What effect has heat upon the rate of diffusion?

Among bodies of equal diffusibility, what other relationship is frequently observed?

What is meant by dialysis?

Define the terms osmosis, endosmosis, and exosmosis.

RECAPITULATION.

Various bodies in solution in water diffuse into pure wa at very unequal rates. Those which diffuse most rapid are called crystalloids, those which diffuse slowly are call colloids. Heat increases the rate of diffusion. Isomorpho compounds have usually about the same diffusion ra Hydrated membranes afford little obstruction to the passa of crystalloids, but are almost impervious to colloids. The classes of bodies being separated by this means, the process called dialysis. If a hydrated membrane has water on one si and a solution on the other, they flow through the membra at different rates; this flow is called osmosis. If the flow water into the solution preponderates, it is called endosmosi if the flow of the solution into the water preponderates, it called exosmosis.

LECTURE VIII.

EVAPORATION, BOILING, FUSION, AND CALCINATION.

Vegetable Juices – Evaporation over Naked Fire—Mechanical Stirrers—Sand Bath, Water Bath, Saline Bath, &c.—Evaporation *in Vacuo*—Rate of Evaporation and of Vaporization—Fusion—Behaviour of Crystalloids and Colloids at their Melting Points—Latent Heat of Fluidity—Behaviour of Fusible Crystalloids and Colloids under the Action of Heat and Solvents—Utensils for Fusions—Calcination.

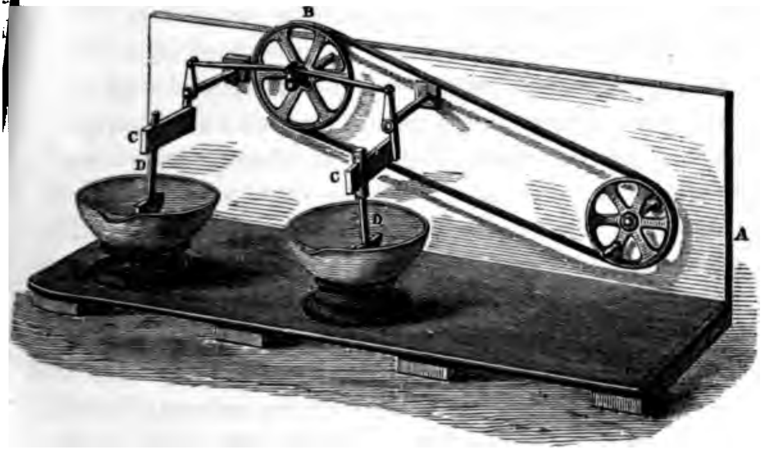
In treating of the desiccation of herbs, I pointed out the general laws of evaporation, and described some appliances which are available in the evaporation of water. We have now to consider such appliances to be used, and such general rules to be observed, in the evaporations of liquids, as did not then come under our notice.

Vegetable solutions for the preparation of extracts being more prone to decomposition than the herbs from which they have been extracted, require considerable care and great promptitude in their reduction to such a degree of concentration as puts them out of danger of fermentation; compared to the drying of herbs, we have now a much greater quantity of water to evaporate; the active principles are deprived of the protection which their natural covering generally affords, and the liquid, instead of being diffused, as it is in the leaves and branches, allowing free circulation for the air, now lies compactly at the bottom of the pan; there is consequently tenfold urgency to have recourse to every artificial means of expediting the process, and to have a vigilant eye upon all the chances of injury to which the liquid is exposed.

With the view of expediting evaporation, the pans used fo this purpose are constructed very wide in proportion to thei depth, and when set upon the fire for active ebullition, which is sometimes admissible, only the centre of the bottom of the pan is exposed to the direct action of the fire; the residue, which is apt to adhere to the pan just above th surface of the boiling liquor, is thus in a measure protecte from scorching; but as a further protection, it should b frequently washed down from the sides by stirring the ho liquor, and driving it from one side to another. Evaporatio over a naked fire will require pretty constant attention in a cases where an organic material is being operated upon.

In most cases, at a certain stage in the process, a film appea upon the surface of the liquid, which very much retards it evaporation. This is to be avoided by constant stirring, whic is usually performed by hand, except in laboratories whe evaporation is so constantly going on as to make it wort while having mechanical contrivances to save the time of th operator. A circular movement may be given to the stirring rod by attaching it to a wheel moved by machinery, but a this moves in one direction at a constant rate it is not nearl so effective as stirring by the hand, which moves the fluid i described, is to run an endless band of calico over three rollers placed in the position of the angles of an inverted triangle such as the letter V, the roller representing the apex being in the pan of hot liquor; motion is communicated to one or both of the other rollers. The band is thus continually drawn out of the pan saturated with hot liquor, much of which evaporates before returning down the other side of the V, nearly cold, into the pan. As both sides of the band are exposed to the air, and it is easy to have its size ten or twenty times as great as the surface of liquor which would otherwise have been exposed to evaporation in the pan, the process is greatly expedited.

Fig. 13.



Reynolds's Mechanical Stirrer.

The material of the pan should be copper, block tin, or enamelled iron: the first and last being preferred for movable pans, the second for pans fixed in steam jackets, &c.

Various arrangements are made for regulating the heat as applied to evaporating, boiling, or distilling apparatus.

Appliances of this kind are called baths, and have distinctive prefixes, according to the material used to regulate the conveyance of heat from the fire to the fluid under operation.

Sand, water, steam, oil, glycerine, saline solution, and fusible metals are all in turn used for this purpose, each having advantages for particular operations.

The sand bath consists simply of sand laid upon an iron plate heated by the fire. It prevents rapid changes of temperature, but does not afford security against too great heat. The saline bath may be used when a temperature a few degrees above boiling water is required, and where a heat much higher would be injurious. It consists of a pan set in another pan, charged with a saturated solution of some salt, which boils at about the temperature within which it is desirable to keep the contents of the bath. As long as any water remains in the lower pan, the temperature never rises above the desired point; and as long as the water is replenished in quantities insufficient to dissolve the whole of the salt, the temperature will never fall below the required point. The cut (Fig. 14) represents a bath of this kind, with a pipe for the escape of the excess of steam surrounded at its upper portion

Fig 14.

ordinary water bath in which the lower pan is always retained at 212° Fahr. (= 100° C.), the upper, of course, being a few degrees less; thus the saline bath may be used for boiling down watery liquids, while the water bath can only be used for evaporating them below the boiling point.

The steam bath admits of a certain range of temperature from the boiling point upwards, according to the pressure which the apparatus is calculated to sustain. There are more difficulties in getting all the joints sound in proportion as the pressure increases, but in any considerable laboratory this is amply compensated for by the convenience of having one boiler and fire supplying heat to almost any number of pans, the pans being connected or disconnected at any moment by simply turning the steam-cock with which each pan is supplied.

The steam bath is constructed of two pans riveted or bolted together at the edges, the lower pan being deeper than the upper; there is a space between, into which the steam is allowed to enter, a provision being also made to carry off the water resulting from condensation.

The evaporation of a vegetable liquor cannot safely be conducted over the open fire after it has acquired the consistence of syrup, but the great majority may be evaporated in a steam bath, working with 4 or 5 lbs. pressure, without any fear of injury; the Pharmacopœia, however, directs the evaporation of many of the extracts at a temperature not exceeding 140° or 160° Fahr., at other times directing simply that a water bath should be used, in which case the heat of the extract will be about 170°, 180°, or 190° Fahr. so long as it remains fluid, but may rise to within a few degrees of the boiling point as it becomes thick, and evaporation goes on so much more slowly. In any case where it is imperative to keep the temperature below 140° to 160° Fahr., the use of the thermometer becomes necessary. It may either be placed in the extract or in the water of the lower pan, which is in some respects more convenient; but in this case it must be remembered that the extract will be a few degrees, though an uncertain numbe degrees, lower than the thermometer indicates.

Below the boiling point the rate of evaporation is increa the more nearly the temperature approaches 212° Fahr., larger the surface exposed to the air, the more perfectly surface is kept free from pellicle, and the more rapidly the passes over the surface.

At the boiling point the rate of evaporation (or vaporizat as it is then called for distinction) increases in proportion the supply of heat to the pan, and the amount of pan sur which is covered by the liquor.

So far I have directed your attention to the evaporation liquors under ordinary atmospheric pressure. A most im tant improvement in the process is to conduct it in a clo vessel, constructed like the steam bath, with the addition o air-tight cover, the air being then exhausted by means of air-pump worked by a steam-engine. The evaporation, un these circumstances, takes place with equal velocity at 80 90° Fahr. lower temperature. Rapid evaporation can t be accomplished without fear of injury from over-heati and contact with air is entirely avoided. Extracts prepa in this way generally preserve in a higher degree the nat

FUSION OR LIQUEFACTION BY HEAT.

The term fusion is commonly restricted to the liquefaction of such substances as require for this purpose a high temperature, but it is both more convenient and more philosophical to treat all together, the melting of ice or of cast iron being just the same as regards the principles involved, and the appliances to be used for the one are linked in an unbroken chain of slight modifications with the arrangements required for the other.

The pharmaceutical operations in which fusion is required are very numerous, but, generally speaking, also very simple; they consist of such processes as making plasters or ointments, the casting of caustic, nitre balls, &c., the purification of bismuth, sulphuret of antimony, gum resins, &c.,

Fusible solids, when gradually heated to their melting point, do not all behave in the same manner; thus, wrought iron becomes soft, plastic, and adhesive before it melts, but cast iron becomes brittle and crumbly; other substances, such as nitrate of silver or of potassium, undergo no very visible change until liquefaction takes place. It has been supposed that bodies change from the crystalloid to the colloid state of matter as they assume the plastic state which precedes fusion. When fusion commences, they combine with heat in such an intimate manner, that the further addition does not cause any rise in temperature till the whole of the substance be liquefied. The heat thus disappearing is called latent heat of fluidity; its quantity varies very much with different materials, as is indicated in a few examples in the following table:—

LATENT HEAT OF FLUIDITY.

	Fahr.		Fahr.
Water . . .	142°	Bismuth . . .	22°
Nitrate of soda .	113°	Sulphur . . .	16°
Nitrate of potash .	85°	Lead . . .	9°
Zinc . . .	50°	Phosphorus . .	9°
Tin	25°	Mercury . . .	5°

Thus, 1 lb. of ice at 32° Fahr. will absorb as much heat in becoming water at 32° as would have sufficed to raise 1 lb. of water at 32° up to 174°. Or, to put it in another way, 1 lb. of ice at 32°, and 1 lb. of water at 174°, when mixed together, will make 2 lbs. of water at 32°.

This law has a practical bearing upon the melting of various substances, which are liable to be injured by exposure to a heat a little above their melting point; thus a pan of ointment or plaster may be kept upon the fire with little fear of injury so long as a portion remains unmelted, but to keep it there, even a few minutes, after fusion is complete, would be at considerable risk of its injury, for then the heat added causes a rapid rise of temperature.

It may be stated as a rule, that fusions should be effected at the lowest practicable temperature. The next table shows the melting points of various substances in which pharmaceutists are interested:—

MELTING AND FREEZING POINTS.*

	Fahr.		Fahr.
Mercury . .	− 39°	Spermaceti .	+ 112°
Oil vitriol .	− 30°	Wax . .	+ 143°
Proof spirit .	− 7°	Iodine . .	+ 224°
Bromine . .	− 4°	Sulphur . .	+ 239°

the wax and the spermaceti being equally perfect at their melting points, but the wax remaining in more intimate union on the subsequent cooling.

If the experiment be repeated with rosin, a thick semi-fluid is obtained on cooling without any separation of the rosin. In these three cases we have the rosin a colloid, the spermaceti a crystalloid, and the wax an intermediate body, and they illustrate the different behaviour of fusible bodies belonging to these classes when subjected to heat, the spermaceti undergoing very little softening previous to fusion, while the rosin passes by imperceptible degrees from the solid to the liquid state.

In the production of ointments and plasters, that condition between hardness and fluidity is aimed at which is best obtained by the presence of at least one body of a colloid nature. I must state, however, that I am at present using the terms colloid and crystalloid without reference to their diffusive powers, as this property has not yet been investigated for many substances insoluble in water.

The appliances used for fusions are very various, depending upon the chemical relationships and the melting point of the substance in hand. Thus, a water bath of glazed earthenware is very suitable for ointments and most things requiring a heat below 212° Fahr. Copper pans are suitable in many cases where a slightly higher heat is required, or where a material, from its hardness or adhesiveness, would endanger earthenware in its subsequent removal. Copper pans, however, are quite unsuitable for melting sulphur, nitrate of potash, hydrate of potash, or nitrate of silver, as these materials have a powerful action upon copper; iron is much less affected by them. Platina vessels may be used for the fusion of nitrate of silver, &c., but would be destroyed by sulphur. Porcelain may be used for sulphur or nitrates, but would be attacked by caustic alkalies. Fire-clay crucibles are little acted upon by most pharmaceutical products, except the caustic alkalies, but are too porous to be suitable for valuable materials like nitrate of silver; they are special suited to fusion of metals, and operations requiring a ve high temperature.

They are subject to two inconveniences, viz., that th are liable to crack, and will rarely bear more than two three heatings, unless used with considerable care, and on exposed to a moderate heat. The absorbent character of t material, also, will commonly render a crucible which has be employed for one operation unfit for another of a differe nature. I have frequently used crucibles of fire-clay mix with plumbago, and find them capable of standing a gre many re-heatings without cracking, but they become rath crumbly and very porous with long use, as the plumba burns out.

Calcination is rarely performed by the pharmaceutist; th inconvenience of having many different small operations, a the cumbrous appliances required for their performance, great measure exclude calcination from the list of laborato processes, such chemicals as require it being better made the large scale, where the apparatus is in constant use for t same purpose.

The process consists essentially in exposing a substance atmosphere of carbonic acid, the evolution of the gas taking place much more readily in a current of air, especially if accompanied with carbon and hydrogen, which decompose the carbonic acid into carbonic oxide at the moment of its liberation. Thus, limestone is much more easily converted into quicklime if burnt in contact with the fuel than if heated in a close retort. Artificially prepared carbonate of lime is more easily reduced to the caustic state than the native limestones, and if pure lime be required, the precipitated carbonate may be calcined in a covered crucible at a heat below whiteness. Magnesia and oxide of zinc, prepared from the carbonates, require a low red heat. Burnt alum and dry sulphate of iron are produced by a heat considerably below redness, a higher heat driving off not only the moisture but the acid. Sulphate of manganese is purified from iron by calcining at a full red heat, which does not decompose the sulphate of manganese but converts the sulphate of iron into sulphurous acid, which is driven off, and peroxide of iron, which is afterwards separated by dissolving the manganese salt and filtering out the insoluble peroxide. In calcining the sulphate of iron for use as dried sulphate, the danger is in having the heat too high; in calcining the sulphate of manganese to purify it from iron, the danger is of having the heat not high enough.

QUESTIONS FOR EXAMINATION.

What temperatures are usually desirable in the evaporation of vegetable juices?

What are the disadvantages of temperatures too high or too low?

What are the usual modes of regulating the temperature of evaporating liquors?

What is the essential advantage of a water bath over that of a sand bath or naked fire?

How does stirring promote evaporation?

What circumstances expedite the evaporation of a liqu kept below its boiling point?

What circumstances determine the rate of vaporization a liquor at its boiling point?

In what respect should we vary the appliances for boili when our object is to produce a decoction?

What difference is observed in the behaviour of crystalloi and colloid bodies just below their melting points?

What useful application have we for fusible colloids pharmacy?

What is meant by latent heat of fluidity? Is it of variab amount?

What is the nature of calcination?

RECAPITULATION.

Evaporation of vegetable juices requires to be perfor promptly to avoid decomposition. They are liable to inj by too high a heat, or too long a continuance of a tempe ture insufficiently high; the temperature is convenien points. Fusible crystalloids sometimes become more brittle before they melt.

During fusion a certain amount of heat disappears; this is known as the latent heat of fluidity, and varies much with different bodies.

Fusible colloids are required in plasters and ointments, to give them adhesive and plastic qualities.

Calcination consists of heating a substance strongly, to drive off volatilizable constituents, or cause oxidation, and leave a powdery residue.

LECTURE IX.

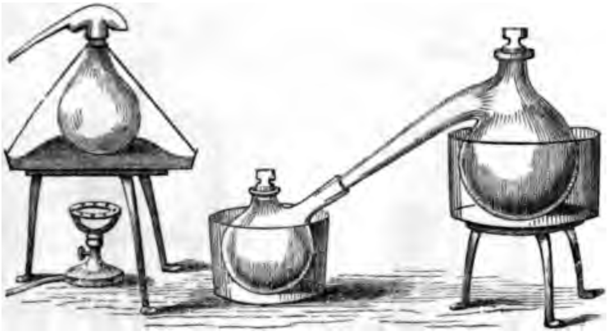
DISTILLATION AND SUBLIMATION.

**Forms of Apparatus—Alembic—Retort and Receiver—Flask and Safet
Funnel—Tubulated Condenser and Receiving Bottle—Liebig's Co
denser—Boiler and Worm Tub—Fractional Distillation—Boilin
Points of Mixed Liquids—Boiling Points of Essential Oils—Distill
tion of Essential Oils—Condensing Power of Cold Water—Mitsche
lich's Condenser—Bumping—Sublimation—Calomel Hydro-sublimatio
and Dry Sublimation—Iodine.**

We have considered the conversion of water and other liquid
into the gaseous state, and have now to study the means
reconverting their vapours into liquids. The two processe
taken together constitute distillation. The objects of distill
tion may be either the separation of two mixed or combin
substances or the combination of elements into new co
pounds, and occasionally both combination and separation

advantage of being entirely of glass, there being no cork or india-rubber connections and no luting, but the disadvantage of being very inefficient in condensing power. The body, or flask-like portion, with its contents, should be set in a sand bath, a cone of paper or card placed over it so as to keep the whole flask hot, and then the head put on. The cone in some measure prevents the heat reaching the head, but for its more effectual cooling it should be fitted with a cap of thick cloth or filtering paper kept constantly moist. The retort and receiver is a much more convenient and useful arrangement, and now that they can be had with the beak of the retort ground into the receiver, forming an air-tight joint, there is scarcely any purpose to which the alembic may be put that is not better accomplished by this apparatus. The receiver may be immersed in cold water, while the retort is heated by a water bath, sand bath, gas furnace, or any other means. The two preceding arrangements are scarcely suited to anything beyond experimental purposes; for operations on a larger scale more substantial and capacious vessels must be used, which are not easily fitted air-tight by grinding.

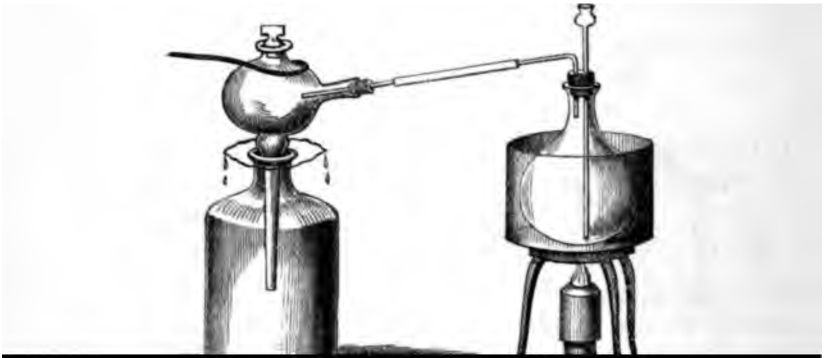
Fig. 15.



The following is an arrangement (Fig. 16) which I have frequently adopted for working quantities from a pint up to half a gallon:—

A large flask is fitted, by means of a cork, with a tube-funnel and bent tube; the flask is set in a water bath over a gas furnace. The bent tube is connected by means of an india-rubber tube to a second glass tube, fitted by a perforated cork to the tubulated receiver (which, when thus used, would be more properly termed the condenser); round the top of the tubulure of the receiver is fitted a collar of leather or sheet india-rubber, and then the tubulure is inserted in a half-gallon bottle. Round the top of the receiver is carried a small india-rubber tube supplied with water, and perforated so that the water shall trickle down in small

Fig. 16.

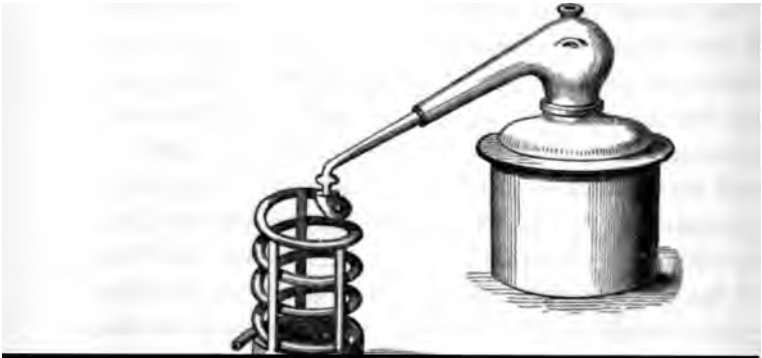


or ejection of its contents through the funnel, would be endangered; it also affords means of admitting air in event of there being excessive condensation. The tube-funnel attached to the flask answers the double purpose of safety against sudden condensation, and a means of refilling the flask when the great bulk of the liquor has distilled. If the condensed liquor rises in the bottle above the bottom of the tubulure, and sudden condensation takes place, the contents of the bottle would be drawn up into the receiver, and possibly even into the flask, were it not provided with the tube-funnel. This arrangement is suited for recovering the spirit in the preparation of alcoholic extracts, &c. It may also be used for the distillation of spirit of nitre, &c. In which case, or in any others where the india-rubber tube is objectionable, the bent tube from the flask may be fitted to the condenser direct; but this makes the apparatus rigid, and consequently less convenient. Liebig's condenser is an efficient and convenient piece of apparatus suited for processes of any moderate magnitude. It consists of two tubes fitted one within the other, with a space between for water. The inner tube is of glass, the outer of glass, metal, or any other suitable material; they are placed either vertically or in a sloping position, the vapour to be condensed being passed *down* the inner tube, while cold water is made to flow *up* the space between the two. This is economical of the water used for condensing, as each portion of water in its passage up the tube continues to abstract heat from the vapour, till at last it may flow away at almost as high a heat as the vapour enters; and the vapour, as it descends, parts with heat at every step, always coming into juxtaposition with water colder than itself till it is condensed into a liquid, and flows out at the bottom, it may be not much warmer than the cold water supplied for its condensation. One great recommendation of Liebig's condenser is, that when sufficiently large it is thoroughly efficient, at the same time that it is easily cleaned, and presents no junctions liable to be acted on by corrosive chemicals: it

may be used in turn for aromatic waters or spirits, for et
nitric acid, or bromine.

Stills of a few gallons' capacity are often made of st
ware, in the form of a retort, or more advantageously,
body and head may be made separate, as in Fig. 17,
junction being made air-tight by grinding the two p
together or by luting. They are suitable for the distilla
of acids and other corrosive materials, or such as requi
high heat. In this case they are set in sand, contained in
iron pot, heated by a furnace. If used for distilling oi
vitriol, a hood should be placed over the still head to pro

Fig. 17.



effected by passing mixed vapours through a series of condensers, the temperatures of which are regulated, and each one being cooler than that which precedes it. This method is sometimes used in the distillation of spirit, to save a second rectification.

By way of a further illustration of this method, we will suppose it is desired to separate water and alcohol from ether, in which case the condensers may consist of three Woulff's bottles. The vapours from the still being passed into the first, which is placed in a tub of water at 190°, water vapour will here be condensed; but its temperature being above the boiling point of alcohol, its vapour will pass on to the second, the temperature of which is regulated to 120°. Here the alcohol condenses, its boiling point being 170°; but the ether, the boiling point of which is 98°, passes on to the third bottle, which should be kept at the lowest convenient temperature. It does not often happen that there is occasion to separate these three from one another, but the separation of water from alcohol is done in this way to save a second distillation. The last bottle may be replaced by any other form of condenser; and if there are only two vapours to condense, only one bottle need be interposed between the still and the ultimate condenser. On the other hand, if coal oils are being distilled, any additional number of bottles may be used, according to the number of qualities into which it is desired to divide the distillate. This method is known as fractional condensation. In theory we might expect that the separation of mixed fluids of different boiling points would be perfectly effected in this way; but this is not the case: though water will not boil below 212° at ordinary pressure, yet it will evaporate rapidly at 190°; consequently a considerable portion of its vapour may be carried along with the alcohol, and condensed in the next receiver. This is a species of action constantly going on in the still. The contents of the still being two liquids of different boiling points which are freely intersoluble, the boiling point is usually found somewhere between the boiling points of the two liquids; but if they are not freely intersoluble, the mixture boils at about the boiling point of the more volatile, and yet the less volatile will distil to a large extent along with it. The former case is illustrated in the distillation of spirit, which boils between the boiling points of alcohol and water, the boiling point varying according to the proportion of the two; and as the distillation proceeds, the more volatile liquid coming over most rapidly, the boiling point of the mixed liquor in the still is continually rising, till the whole of the alcohol has come over, and the temperature of 212° Fahr. has been attained.

The latter case is illustrated in the distillation of essential oils. The oils boil at a much higher temperature than the water; yet a mixture of the two boils at nearly the same heat as pure water, and the boiling point does not rise so long as water remains in the still; but if an essential oil be distilled without the presence of water, the case is very different. Most of the essential oils, as obtained by distillation from plants, contain two or more substances of different degrees of volatility, which, though not freely soluble in water, are freely soluble in one another, and when subjected to dry distillation, the more volatile coming over first, the boiling point continues to rise till a uniform substance remains in the still, or till the whole has been brought over. The table

BOILING POINTS OF VARIOUS ESSENTIAL OILS.

	Fahr.		Fahr.
Hops, from	284°	Chamomile	347°
„ to	600°	Bergamot	361°
Mustard	298°	Aniseed, solid	432°
Turpentine	320°	Caraway	437°
Juniper	320°	Cloves	469°
Savine	320°	Ginger	475°
Thyme	329°	Cubebs	500°
Lemon	343°	Copaiba	500°*

Great care is requisite in the distillation of essential oils to avoid empyreuma. The great bulk of the material to be operated upon, its liability to scorch upon the bottom of the still, and thus injure both the still and its contents, is a source of constant trouble, unless special provision is made to obviate these accidents. The accompanying table shows the highest and lowest estimate of the yield of essential oil from 100 lbs. of various vegetable materials, the number indicating ounces and decimal points. Thus, 100 lbs. of dry chamomile flowers yield 1·38 ounce essential oil; another sample of the same yielded 5·33 ounces; 100 lbs. of good mace yielded 154·0 ounces of essential oil, and 100 lbs. of worm-eaten mace only yielded 65·60 ounces.

100 lbs. of		Essential Oil in ounces.		
Bitter almonds	yield	0·38	to	7·70
Chamomile flowers, dry	„	1·38	„	5·33
Caraways	„	46·00	„	70·00
Cloves	„	112·00	„	272·00
Juniper berries	„	7·75	„	16·15
Lavender herb	„	9·00	„	15·00
Rose flowers	„	0·25	„	...
Black mustard-seed	„	3·90	„	9·10
Peppermint, fresh	„	3·40	„	6·25
„ dry	„	15·62	„	21·00
Nutmegs	„	64·10	„	108·25
Mace	„	65·60	„	154·00†

To avoid the burning, the materials are sometimes placed in a chamber or cucurbit, and only exposed to the current of steam which passes through them on its way from the boiler to the condenser; others put the herb into the water, but keep

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* Compiled from Miller's "Elements of Chemistry."
† From Christison's "Dispensatory."

it off the bottom of the boiler by means of a false bott
wickerwork or perforated metal.

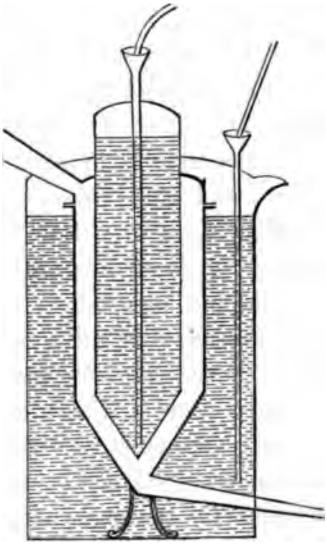
It is found that the oil comes over more freely if the
rial is in actual contact with the water, than if it is onl
posed to the action of the steam; consequently, if an aro
water is desired, the latter process may be used; but
object be to separate the oil, direct contact with the w
to be preferred. The undissolved portion of oil may be
rated, and the water returned to the still with more
herb, by which means the loss of oil from its solubil
water is in great measure avoided.

The quantity of cold water required to condens
products of distillation is very considerable, and while
necessary to make ample provision, it is also necess
have a regard to its economy by using good conde
&c. The ordinary worm-tub is very efficient, easily
structed, and not liable to get out of order; but ha
great disadvantage in the difficulty of getting it thoro
clean after it has become impregnated with essential o
It is, therefore, better adapted to the use of a manufa
who has to prepare large quantities of a small numb
preparations, than for the ordinary pharmaceutist, wh

We may state the latent heat of water roughly as 1000° Fahr. (= 555° C.). The available absorbing power of water is the difference between the temperature at which it is supplied, say 60° Fahr. (or 15° C.), and that at which it afterwards runs to waste, say 160° Fahr. (70° C.), in which case its absorbing power would be 100° Fahr. (55° C.), and it would be necessary to supply 10 gallons of cold water for the condensation of one gallon of aqueous distillate. If the waste water flows away at a higher heat, of course so much less may suffice; but, on the other hand, if the condensed liquor flows off at a temperature below 212° Fahr. (100° C.), so much more must be allowed for this absorption.

The condenser of Mitscherlich (Fig. 18) is also a convenient and efficient piece of apparatus, which is easily cleaned. It consists of a condensing chamber made of metal, tin being the material most generally suitable; inside this chamber is a cylinder kept supplied with cold water, which runs in at the bottom and flows over the top into the tub in which the condenser is placed. The tub is also supplied with cold water in the same way. The chamber being made in two pieces fitted together by flanged rims, it can be opened, and the essential oil, &c., thoroughly cleaned off between one operation and the next.

Fig. 18.



Mitscherlich's Condenser.

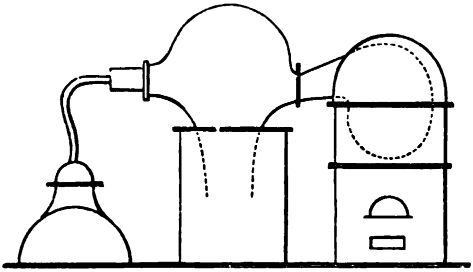
In many processes of distillation, or even of boiling in an open glass vessel, the phenomenon known as bumping is a constant source of annoyance and even danger. The phenomenon has not yet been satisfactorily explained, though it has received the attention of various illustrious men; it is found that many liquids will boil freely and quietly at first, but after a while the ebullition takes place in bursts sometimes so violent as to eject the whole contents of the flask or retort, or even to break the glass by the violence of the concussion. The temperature of the liquid is found to rise much above its usual boiling point between each burst of vapour, the accumulated heat then suddenly evolves a large bulk of steam, and the temperature falls at once to the normal boiling point.

This phenomenon is most noticed when boiling liquids in glass vessels with smooth clean surfaces. Indeed, Mr. Tomlinson has shown that pure water cannot be boiled in a perfectly clean glass without considerable bumping. It has been a common practice to put a few chippings of platinum foil, or a few chips of flint, into retorts with the view of facilitating the steady evolution of vapour; but it is found that after a time these nuclei cease to have the effect, and bumping recommences. Mr. Tomlinson's remedy, which he says is perfectly successful, is to put a few fragments of charcoal into the retort; and where charcoal is not admissible, as in the distillation of oil of vitriol, he recommends pumice-stone, the efficacy of these substances no doubt depending upon the singular and unexplained relationships which subsist between it is desired to obtain it; thus, camphor is preferred in the massive state, calomel in an impalpable powder, and sulphur in both forms.

When it is desired to condense the sublimate in compact masses, the atmosphere of the condensing chamber should be so hot that the vapour does not condense till it comes in contact with the sides of the chamber; the sublimate will then deposit upon them layer after layer, in a condition more or less crystalline and compact.

When the pulverulent form is required, the vapours should condense from coming in contact with a cool atmosphere, which may be managed by having the condensing chamber large and sufficiently ventilated. Attention must also be paid to the degree of volatility of the material in hand; thus, iodine and camphor volatilize freely at atmospheric temperatures, and a current of air passing through the condensing chamber would entail considerable loss, while calomel and sulphur do not evaporate without a considerable rise of temperature. Ventilation is out of the question in subliming sulphur, as it inflames below its boiling point; but with calomel, ventilation either with air or steam is the usual process.

Fig. 19.

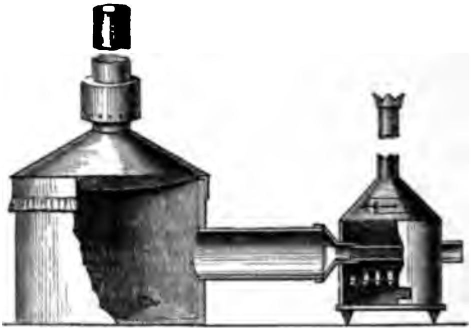


Hydro-sublimation of Calomel.

The following figures may be taken as representing the process of sublimation in a sufficient variety of forms for our present purpose. First (Fig. 19) the hydro-sublimation, as contrived by Mr. Sewell, of Howard & Co. The crude calomel being introduced into the stoneware retort heated over a furnace, the vapours are conducted into a stoneware receiver which has three openings, the first to receive the calomel vapour, the second to receive a jet of steam, and the third dipping into water carries down the calomel and condensed water together. The calomel is thus obtained in an impalpable powder, and any corrosive sublimate which may be condensed at the same time is washed away in the water.

The other method (shown in Fig. 20) is to heat the crude calomel in a stoneware tube, through which a gentle current of air is constantly flowing into a chamber of such size that

Fig. 20.



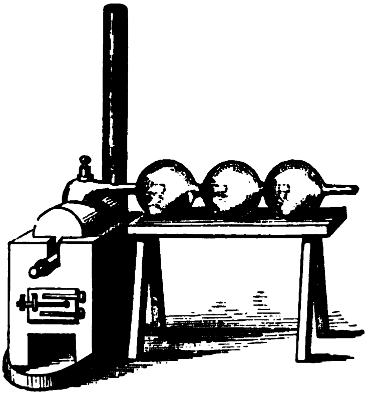
Dry Sublimation of Calomel.

a very small extent, decomposed into corrosive sublimate and metallic mercury.

Recently it has become the custom to condense camphor in the pulverulent condition by the use of capacious condensing chambers. It is sent into commerce under the name of flowers of camphor, in the form of a crystalline cohering powder, which by powerful pressure may be consolidated into compact blocks of any size or shape.

The third figure (Fig. 21) represents the sublimation of iodine. The crude alkaline iodides are put into the lead still with oil of vitriol and black oxide of manganese; on the application of heat the iodine vapours pass over, and are condensed in the series of glass globes. In this case the fittings must be air-tight, or nearly so, as any current of air would cause the loss of iodine, which is volatile at all ordinary atmospheric temperatures. The iodine is deposited in small crystals, together with some water. The water may be drained and pressed off, and the iodine obtained in large dry crystals by a second sublimation.

Fig. 21.



Lead Still—Glass Condensers.

QUESTIONS FOR EXAMINATION.

What is distillation?

In a solution of volatile liquids, what relation does the boiling point bear to the boiling point of its constituents?

In a mixture of liquids which do not dissolve one another, what will be the boiling point?

What will be the nature of the distillate from a solution or mixture of fluids having different boiling points? A how will the first and last portions of distillate differ from o another?

In what respect does sublimation differ from distillation

What circumstances favour the massive or pulverulent co dition of a sublimate?

RECAPITULATION.

Distillation essentially consists of the conversion of a liqu into its vapour, and the recondensation of the vapour into t liquid state.

The boiling point of a solution lies between the boili points of its constituents: the boiling point of a mixture fluids is about the boiling point of its most volatile ingredie In distilling mixed fluids, the most volatile come over mo rapidly, but the less volatile come over more rapid than they would do at the same temperature if the mo volatile were absent. A solution of liquids of differe boiling points may be approximately separated into its co stituents by regulating the heat of the boiler, or by using series of condensers the temperatures of which are regulate

LECTURE X.

FILTRATION AND PERCOLATION.

Filtering Media, Paper, Calico, &c.—Means of Expediting Filtration—Continuous Filtration — Pressure Filters — Filter Baths—Filtration through Charcoal—Percolation, Theoretical Considerations—Comminution required—Forms of Percolators—Displacement of the Absorbed Liquors—Strong Tincture of Ginger—Modes of Packing the Material—Conical Percolators—Displacement of Spirit by Water—Pharmacopœial Process.

Filtration is one of the many simple operations of pharmacy, which at first sight appears to require scarcely any comment; nevertheless, there is scope for the exercise of intelligence and ingenuity in its many useful modifications.

The process itself may be defined as the passing of a liquid through a porous solid, and its object the separation of suspended or dissolved matter. The solid may be a colander, sieve, or cloth of open texture, in which case the separation of large particles only can be effected, and the process is, for distinction, called straining. It does not separate fine particles or make a turbid solution bright. The filtering medium may be closer, such as a close calico, flannel, felt, paper, sand, pumice stone, asbestos, &c., when the object is to separate fine suspended matter, or charcoal, if the object is to separate matter held in solution.

Paper filters, with which you are all familiar, are made of coarse unsized paper for galenical purposes, or of fine unsized paper for fine precipitates. The coarse paper generally contains a mixture of wool, and is not pure enough for analytical use, but is tougher, and filters many pharmaceutical liquids both rapidly and well. From its thickness, there is more loss by absorption, but as it permits a rapid passage of the fluid, there is little loss by evaporation. It is usually tough enough to bear the weight of a pint or two of liquid, while the thin paper would be burst in the throat of the funnel by such a volume. It is sometimes desirable to use a fine paper within a coarse one, thus combining the toughness of the strong paper with the fine filtration of the thin paper. A greater rapidity of filtration is thus obtained than if the fine paper only had been used. At other times a cone of perforated zinc may be put into the funnel, and the fine paper laid upon it, taking care, however, that such arrangement be not used for any liquid having a chemical action upon the zinc. Filtration will go on much more rapidly if the funnel is well selected as regards its shape, or the paper carefully folded to suit the funnel. If a circular paper be folded across its diameter, and then again at right angles, and opened out to form a cone, it represents the shape of a well-formed funnel. But if this be put into a common glass or earthen funnel, it will often be found that the funnel is either a more acute or a more obtuse cone, or that the sides are not quite straight, in which case the paper is apt to give way, or the flow of liquid to be impeded. I prefer to have the paper folded, so as to produce instead of calico, such as linen, flannel, felt, or paper laid upon calico, according to the nature of the fluid or the precipitate. If paper is to be used, it may have a few plaits folded at the edges, so as to give it a concave form, approaching the shape the strainer will assume when stretched with the weight of the liquid. It should then be put in its place and filled with water, to make sure that it adapts itself without bursting. Whatever may be the nature of the medium adopted for filtration, if the fluid contains sediment which deposits upon the filter, the sediment itself becomes part—and not unfrequently the most efficient part—of the filtering medium, but at the same time retarding the operation, it may be, to an inconvenient degree. Various devices have been adopted to expedite filtration when inconveniently slow. The principal causes of variation in the rate of filtration are as follows:—The filtration is quicker the more porous the medium, the thinner the stratum of the medium, the greater the pressure of the liquid upon it, the greater the freedom of the liquid from sediment, which might choke the medium, and the greater the mobility of the liquid.

It is obvious that some of these circumstances do not admit of change at our pleasure, others only to a small extent. Thus the porousness or openness of texture of the filtering medium will depend upon the fineness of the sediment to be separated; but we may at least avoid the use of a close texture when an open one is all that is required. Then, as regards the choking of the filter in any case where this is apt to occur, we may in some measure obviate it by allowing subsidence to take place, and decanting as much as possible of the fluid into the filter in a more or less clear condition, that there may not be a large bulk of fluid to filter after the medium has become choked with deposit. If slowness of filtration results from viscosity of the fluid, it may in most cases be accelerated by heat. This is very noticeable in the filtration of oils; but if the object be to separate the frozen portion of the oil from that which has a lower freezing point, the application of heat would defeat the object in view. T principal contrivances which have been devised for expedit filtration depend upon the increased pressure which t maintain upon the fluid in contact with the filtering surf The contrivances for maintaining a given temperatu though they may be used to expedite filtration, have b produced with the object of preventing crystallization, soli fication, or other change in the liquid which might res from a fall in the temperature.

I will now draw your attention to some forms of press

Fig. 22.

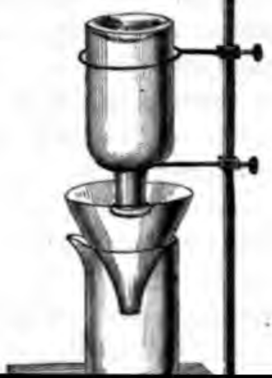
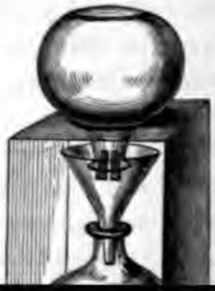


Fig. 23.



the liquid in the filter sinks below the level of the bottle-mouth, a bubble of air enters and a corresponding portion of liquid flows into the funnel, so that the process is kept going on continuously, and as quickly as the pressure of a funnelful of liquid can make it, till the bottle is empty. To avoid splashing and waste of the contents of the bottle, it may be fitted with a perforated cork to restrict the flow, which might be inconveniently rapid during the inversion of the bottle. For quantities of half a gallon, or upwards, it is desirable to have a more substantial arrangement, as shown in the diagram (Fig. 23). A box with an open front has a hole made in the top, through which passes the neck of an inverted carboy containing the liquid to be filtered; inside the box a second carboy is placed to receive the filtrate, the filter consisting of the usual funnel and paper, supported by the lower carboy at such a level that the mouth of the upper carboy comes within the funnel a little below the level of the edge of the filter paper. Operating with vessels of this size, it is most convenient to have the upper one stopped with a perforated cork, the perforation itself being loosely plugged with a cork which can be removed when the apparatus is in working position.

The diagram (Fig. 24) represents a filter I adopted some years ago for filtering castor oil. It consists of a funnel, with a tube about 5 feet long. It is made of tin-plate, with a ring soldered round the bottom of the tube, to enable a filter-bag to be securely tied on. The bag is made of linen of a close texture, and is placed over a jar to receive the filtrate, the funnel being supported by a projecting ledge from a high shelf, and kept full of oil by an arrangement similar to the last. The pressure of the column of 5 or 6 feet of oil causes the filtration to go on pretty rapidly, and if the cloth be of close texture the result is satisfactory.

The diagram (Fig. 25) shows another arrangement upon a similar principle which I devised for filtering syrups, &c. It consists of two tin-plate funnels, connected by an india-rubber tube, the upper having the same arrangement *for* keeping it full, the lower being of an obtuse form, and having the filtering material stretched over its mouth, which hangs downwards over a jar which receives the filtrate. The filtering medium may consist of either cloth alone, or paper and cloth. In the latter case, of course, the cloth is put outside to support the paper. If a large quantity is to be operated upon, the funnels may be reversed, the narrow one being below, and having a filter bag attached, similar to that used for oil in the last arrangement.

One disadvantage of both these plans is, that at the

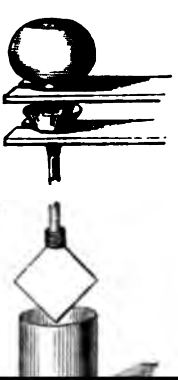


Fig. 24.

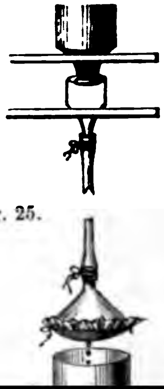


Fig. 25.

erforated plate, E, and upon this plate is placed the filter aper or cloth, cut circular and a little larger than the iameter of the funnel. The edges thus become turned up gainst the sides, and are kept in close contact with them y a tin ring, F, which is made so large that it just fits ghtly into the bottom of the upper section, when the ickness of the paper or cloth is interposed between the ng and the sides of the funnel; it thus lies upon and ithin the turned up edges of the paper, and prevents y of the fluid escaping filtration. To work the apparatus, filtering medium being fixed in place, the liquid to be ltered is poured into the funnel, the india-rubber tube closed t H with a pinchcock, till the filtrate fills the tube and begins appear at the hole in the lower part of the funnel at G. his hole is then plugged, and the pinchcock opened, which hould result in rapid filtration till the whole contents of he funnel have passed through. The efficiency of this ystem depends upon atmospheric pressure. Under ordinary ircumstances there is an atmospheric pressure upon the iquid in the filter, amounting to 15 lbs. on each square ich, but this is balanced by an equal pressure in the opposite irection, exerted through the opening in the neck of the

Fig. 26.

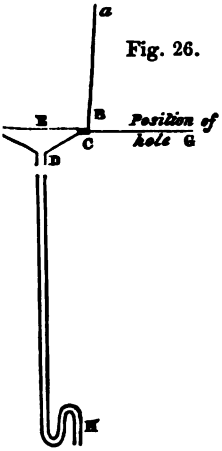
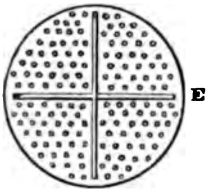
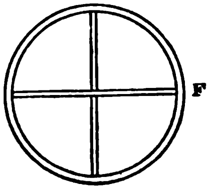


Fig. 27.



Perforated plate strengthened with cross bars below.

Fig. 28.



Ring with cross bars above.

Schacht's Filter. Conference 1865, Birmingham.

funnel; but when the long tube is attached, the under pre sure is diminished to the extent of the weight of the colum of liquid contained in the tube. Professor Attfield h stated that there are other forces in operation; but we hav not at present time to enter into a discussion of this questio and I may just state that the efficiency of this mode is sai to be as great as that in which the pressure column is abov the filter, with the advantage that it does not cease to act ti the last portion of fluid has been forced through, but in som respects it is not quite so simple in management.

Another method by which we can readily expedite filtra tion, is to fit a funnel to one neck of a Woulff's bottle b means of a perforated cork, and to withdraw the air throug the other neck. In this case the filter paper requires a su port just at the throat of the funnel, or it would inevitab give way. For pharmaceutical use a little funnel-shap cone of zinc, tin, or copper, either with or without perfo tions, loosely placed in the funnel, will afford the requi support without preventing the flow of liquid between t funnel and the cone. The cone should be free from sha projections or roughnesses, which would cut the paper, a should fit the funnel as closely as practicable. For ana

Filter baths are used for keeping filters hot while hot saturated solutions are being filtered, or to prevent the solidification of some body which has been liquefied by heat, such as lard, wax, ointments, &c.

The first (Fig. 29) consists of a box of tin-plate or copper, containing water kept boiling by a spirit lamp or gas flame below. There is a conical space to receive a funnel, and space in the top to receive a flask or beaker of the solution.

Fig. 29.

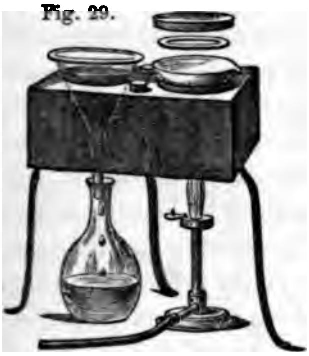
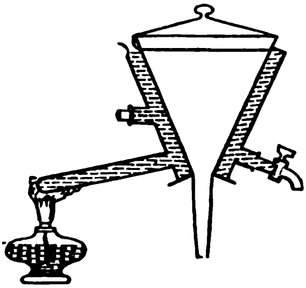


Fig. 30.



The next (Fig. 30) represents a double funnel, the space between the two portions being filled with water kept hot by a spirit lamp applied to a projecting tube.

Fig. 31.

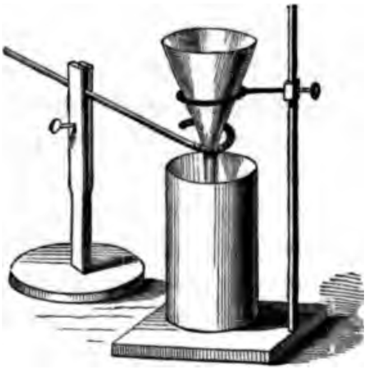


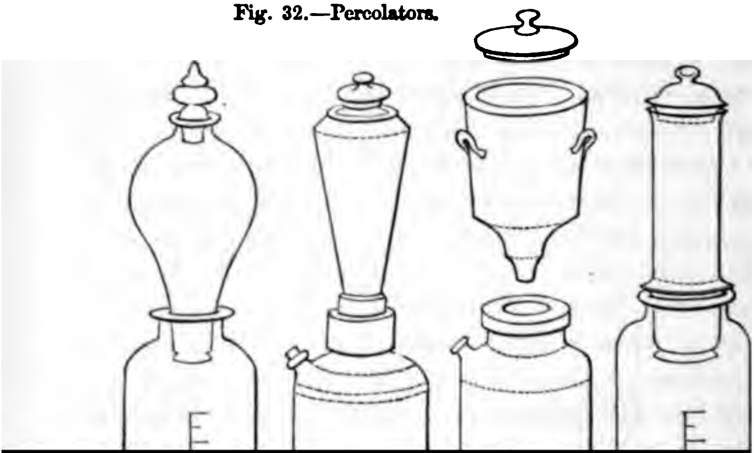
Fig. 31 represents an arrangement in which a funnel is kept hot by a ring of gas jets placed below it, without the intervention of water. I have found it answer quite well for filtering ointments, &c., if carefully employed, attention being paid to using as little gas as may suffice, and not bringing it in too close proximity to the funnel.

Filtration, with the view of removing substances held in solution, is generally effected by passing the liquid through a considerable stratum of animal charcoal, which has the power of absorbing or attaching to itself in some way many soluble substances. This property is possessed by other materials besides charcoal, though not to such a noticeable extent, and the action exerted by charcoal varies very much in degree, both according to the nature and purity of the charcoal, and according to the nature of the soluble matter to be removed.

The solution may be agitated in contact with the charcoa for some time, and then the whole filtered through paper i the usual way, or the charcoal may be put into a percolat tube, and the liquid allowed to pass slowly through it. T animal charcoal of commerce is obtained by burning bones i close chambers, and contains a large quantity of phosphate lime, from which it is necessary to purify it before it is fit f some purposes. The pure charcoal has more power of absorbing colouring matters and alkaloids than that containing th phosphate of lime, and when it is necessary to redissolve a alkaloid which has been absorbed by the charcoal, of cours the presence of phosphate of lime would interfere with th process. On the other hand, the charcoal becomes muc softer and more dusty by the extraction of the bone earth *imparting* something to the liquid. The solid body being reduced to a powder, rough or fine, according to its nature, and packed in a suitable vessel, the liquid is poured upon it, and, as it gradually descends, each particle comes in contact with a succession of different particles of the solid, and becomes more and more strongly impregnated with the soluble matter, till it escapes from the bottom. The solid particles also are brought in contact with a continual succession of fresh portions of the solvent, and part with some of their soluble matter to each, till exhaustion is completed, or till the supply of liquid ceases. Thus, in theory we might expect every portion of the liquid would become saturated before it passed through, and that exhaustion of the solid would be completely effected soon after the liquid ceased to pass through in a state of saturation. This theoretical result is most nearly obtained when the comminution of the solid is carried to its utmost limit, and the column is of considerable depth in proportion to its width. But, even under the most favourable circumstances, these results are far from attainable. The first portion of liquor is rarely saturated, and the exhaustion is never effected without the use of considerably more of the solvent than is capable of retaining the whole of the soluble matter in solution. Percolation is almost exclusively employed for vegetable substances, the soluble portions of which are frequently colloid bodies, with only a small percentage of crystalloids, and if a saturated solution were obtained, it would usually have such a degree of viscosity as to stop the percolation; besides which, the solution of colloid bodies goes on with much less regularity and certainty than crystalloids. This viscosity impedes the percolation the more in proportion as the comminution is more perfect. It is, therefore, rarely practicable to use very fine powders, and the imperfectness and slowness of solution increase in proportion as the comminution is less perfect, so that the theoretical results are *never* obtained and *rarely* approached.

Fibrous materials which do not contain any large proportion of viscid matter may be reduced to the finest possible pow with advantage. Cinnamon, ginger, yellow cinchona, cannot be too fine. Mucilaginous roots, such as rhubarb gentian, must be in a much rougher powder. Myrrh, opi and similar substances are not readily percolated, unless most of the soluble matter has been extracted by a previ maceration, and decantation of the liquor from the insolub the exhaustion of the residue may then be finished percolating a fresh portion of spirit. In all cases where

Fig. 32.—Percolators.



provided with a tap at the bottom of the tube. The York Glass Company's is made with the tube fitting air-tight into the reservoir by grinding, as a stopper is ground into a bottle, but with a flat portion or notch reaching a little more than half-way along one side of each of the two ground surfaces, the notch on the receiver extending from the top of the ground surface a little more than half way down, and the notch on the tube extending from the bottom a little more than half way up. If these two notches are brought in juxtaposition there is an opening for the air to escape from the receiver, but in any other position the fitting is air-tight. The top of the tube is stopped, and notched in the same way. The percolation is stopped by making either of these junctions air-tight, as the liquor will not run into the receiver unless there is egress for the air, nor will it run out of the tube unless there is ingress of air to the upper portion. We may call these adjustable joints, valves. Supposing the lower valve to be shut, and spirit be poured upon the contents of the tube, it will only work its way down by capillary attraction, and by virtue of the compression the air undergoes from the weight of the spirit. If the lower valve be then opened the spirit will flow through, but may at any time be arrested to allow of maceration going on in the tube. Supposing it takes half a pint of spirit to moisten the contents of the tube, and half a pint more to fill the interstices between the particles, the interstitial half-pint will soon become strongly impregnated with the soluble matter, even though it does not penetrate into the cellular spaces of the vegetable to be exhausted—its impregnation depending upon the surfaces of particles exposing soluble matter, and upon the diffusion which takes place through the tissues of the vegetable where they are not ruptured. A third half-pint being poured into the tube, and the valve opened, the interstitial half-pint will run through, its place being taken by the new portion of spirit. But this action is not perfect; a portion of the original interstitial spirit may be retained in the mass; a portion of the intercellular spirit may have come throu; together with a portion of the freshly-added spirit. It is to be expected that the new addition can precisely take place of that which is draining out, without any mixture the two taking place. We have evidence that considera admixture takes place, even under the most advantage circumstances, as seen in the following experiments: A qu of fine sea sand requires half a pint of fluid to fill interstices. The sand being put into the percolator, a half a pint of liq. potassæ permanganatis being poured up it, is entirely held by capillary attraction between the partic of sand. Here we have the interstitial half-pint without a intercellular liquor, or any soluble matter not already d solved, to interfere with the observation, and have, c sequently, the most favourable circumstances for obtaini a clear replacement of the liquor by a like bulk of pure wa being added. But the addition of half a pint of water d not carry through the whole of the coloured liquor. A seco half-pint of pure water being added to remove the first, dri out a highly-coloured solution. A third measure of p water being added, a pale solution percolates, but even n not absolutely colourless. This being the case with or essence of ginger of the British Pharmacopœia. It may be taken as an illustration of what the process is capable of performing under favourable circumstances.

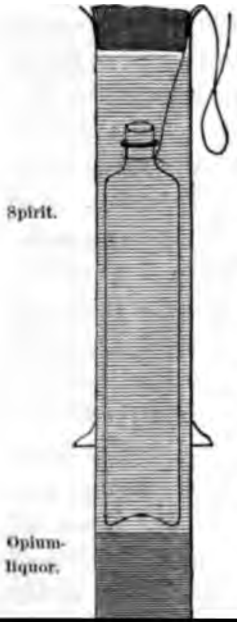
The official instructions are to pack the powdered ginger tightly in the dry state, and then to pour upon it a portion of the spirit equal to half the ultimate product. After this has been in contact with the ginger for two hours, more spirit has to be added, and the percolation slowly continued till two fluid ounces of tincture have been obtained for each ounce of powder used. If the ginger be finely powdered, closely packed, and the percolator tube narrow in proportion to the quantity operated upon, so that the spirit has to percolate a depth of 10 or 12 inches, its downward progress becomes at last very slow, the tincture may be viscid from the quantity of resinous matter dissolved, and too thick to progress satisfactorily. This must be prevented by selecting the size and shape of the percolator so as to avoid such an excessive depth in the column. Some operators prefer to mix the powder for a tincture with as much spirit as reduces it to a creamy consistence, and in this condition pour it into the percolator, allowing it to pack itself, which it usually does sufficiently closely and in a more uniform state than can be readily done by dry packing. It also avoids the excessive viscidity which I have just noticed as sometimes giving trouble, but it is better suited to cases where the quantity of spirit is greater in proportion to the dry materials than in the formula under consideration, because more than one-half the spirit would in this instance be necessary to reduce the powder to the required condition, leaving an insufficient quantity for subsequent percolation to insure satisfactory exhaustion. A third method of packing is to rub the powder with just so much of the solvent as suffices to reduce it to the state of a moist powder. It is said that this expedient prevents the chance of unequal percolation, which is sometimes observed in dry packing, the fluid passing down one side more freely than the other, and finding a channel of least resistance, resulting from some slight inequality in the packing. T testimony in favour of each method is so nearly equal th I am inclined to think all may be successfully worked b careful manipulation. My own experience has only led t conviction upon one point, namely, that the powder, moistened beforehand, must not be worked into a paste; th quantity of fluid must either be so small as to result i simply moistening the powder, or so large as to reduce it t a creamy state—the intermediate pasty condition almo certainly resulting in complete stoppage of the process.

I have also repeatedly observed that the material packe in the creamy condition contracts more uniformly toward the end of the process, and is less apt to crack in doing s and thus leave open spaces. The form of the percolator a matter of some moment, especially when the ingredient are packed dry; many substances swell considerably whe moistened, and if they have not room allowed for expansio become so tight that the liquid will not percolate at al Others contract considerably when exhaustion is nearly com pleted, so as not to fill the space they were at first packe in. They then leave fissures through which the spirit wi pass without permeating the mass. Both these contingenci his usual requirements, but every pharmacist will also have occasionally to employ larger or smaller percolators, and it is convenient to be able to extemporize an efficient piece of apparatus from common utensils; the conical chimney of a lamp makes a very good percolator for small quantities; it may be fitted, by means of a large bung, to a wide-mouthed bottle for a receiver, and should have a smaller bung fitting loosely into the narrow end. The bung having a perforation in the centre, and a few deep grooves cut into its surface, should be covered with flannel and pressed into its place; it thus acts as a support for the materials and a strainer. The neck of a broken retort or champagne bottle, fitted up in the same way, acts very well for smaller and for larger operations. Percolations of a few pounds of material by a few gallons of water, I have worked satisfactorily in coarse conical earthenware jars, such as are used for honey, and for importation of Lucca oil. They may have a hole drilled into the bottom with a file or other hard steel instrument, and may be fitted with an india-rubber teat or tube to guide the flow of percolate. Before packing the materials into this jar, there should be laid upon the bottom one or two thicknesses of flannel, cut to about the size and shape of the bottom of the jar. These not only strain the percolate, but permit of the percolation going on pretty equally through the whole mass, as they drain the whole area, instead of the drainage being limited to the point where the tube is inserted. For larger operations still, I have worked satisfactorily with a 100-gallon cask, fitted with a perforated false bottom, covered with calico, and supported with cross bars just above the tap. The false bottom requires packing round the edge with tow to prevent the materials getting below and choking the tap.

I have used a little modification of the ordinary percolation process, with considerable advantage in the analysis of opium, and some other operations on small bulks. Its nature and merits will be best shown if I describe here the mode of exhausting one or two hundred grains of opium.

Rub the lump opium with its own weight of w
smooth a pulp as possible, if necessary with the aid c
heat; add spirit equal to about three times its we
transfer to a percolator tube
furnished with a loosely-fitt
tube closed at both ends for i
the hydrostatic pressure. A pl
with water and corked, ans
for the inner tube, a string l
round the neck by which it n
down gently till the bottom of
just touches the surface of th
liquor; its position may then
by pressing the string betwee
of the tube and a cork wedge.
thus arranged, more spirit
added till a column of 6 or 8
obtained without disturbing t
or mixing to any appreciab
with the opium liquor, and
using more spirit than is req
the exhaustion of the opium.

Fig. 33.



said regarding the impossibility of getting a perfect displacement of the first portion, by the second portion of spirit, will apply with greater force to the attempt to displace a pint of absorbed spirit by the addition of a pint of water. The disposition which water and spirit have to diffuse into one another, the difference in their gravity, which gives a tendency to the spirit to rise in the water where they come in contact, the greater affinity which vegetable tissues have for water than for spirit, giving them a tendency to swell and choke the percolator, are all objections to the use of water for displacing the spirit; but these objections do not apply with equal force in all cases. I have succeeded with approximately good results in the case of powdered ginger, but when operating upon powdered cinchona, there was more appearance of mixture taking place—a mixture which might readily escape notice, as it was not sufficient to make the tincture turbid; but at the same time it must be admitted that it reduced the alcoholic strength of the tincture, and could not be considered legitimate in an official preparation. The directions of the Pharmacopœia now enjoining pressure after percolation, conveniently economize the greater part of the spirit. If a more rigid economy is still desirable, distillation may be had recourse to.

I have already made several allusions to maceration, and need now only add that frequent agitation is necessary to make the process thoroughly efficient. The marc of a tincture, prepared by maceration and expression, will, of course, retain a certain small portion of tincture which no amount of pressure can expel, and in this case the loss must be a loss of tincture at least as strong as the bulk, and the only essential difference between the economy of the two processes is, that in many cases the loss, in case of percolation, is only a loss of spirit, or of very weak tincture, while the loss by the process of maceration is that of a tincture of full strength. The combined process now in use is superior to either separate system in convenience, economy, simplicity, general applicability, and the quality of the results.

An arrangement of apparatus for the new process is described by Professor Redwood, in the *Pharmaceutical Journal* of May, 1864, by which the necessity for agitation is avoided, the ingredients being suspended in a bag, from which they do not require to be removed till the processes of maceration, percolation, and expression are all complete.

QUESTIONS FOR EXAMINATION.

Describe the nature and objects of filtration.

Describe the different arrangements for expediting filtration.

How does filtration through animal charcoal differ from filtration through most other media?

What precaution is necessary when an absorbed alkaloid is to be extracted from the charcoal by the subsequent use of an acid?

What is the essential difference between pharmaceutical percolation and filtration?

What materials are most suitably exhausted by perc

tration may be expedited by arrangements for keeping
lter constantly full, for increasing the pressure of the
upon the filtering medium, and for maintaining an
sed temperature.

mal charcoal has the power of abstracting from solution
materials when held by feeble solvents, and of yielding
ıp to solution again when subjected to more powerful
ts. The presence of phosphate of lime in the British
ıacopœia purified animal charcoal must be guarded
t in some of these applications.

colation is the passing of a liquid through a porous
omminuted solid, with the object of extracting soluble
r. It is most suited to substances which are not of
ilaginous character, and do not form viscid solutions
he required solvent. Woody materials may be finely
red for percolation; substances yielding a viscid solu-
hould be more roughly comminuted, and should be
ated in a portion of the solvent before being submitted
colation. For roughly comminuted materials alternate
ation and percolation is most advantageous. The suc-
e portions of solvent added do not, under any circum-
s, precisely displace the portions which preceded them.

LECTURE XI.

OFFICIAL PHARMACY.

Pharmacopœial Preparations—Making or Buying—The Pharmacopœia—Mode of Studying—Official Powders in Order—Official Pills—Proportion of Active Matters—Dose—Excipients—Essential Oils used—Mode of Mixing—Modification of Excipients—Official Pills in Order.

THE PHARMACOPŒIA.

AN important part of the pharmacist's duty is the preparing of official compounds from the formulæ of the Pharmacopœia. Every one must decide for himself which articles he should make, and which he should buy ready made; but I may lay it down as a commendable rule, to make occasionally as many preparations as possible, and from a comparison of the homemicals which are of a sufficiently definite character to be cised without this sort of "personal acquaintance" may lly have their quality satisfactorily guaranteed by subing them to the examination indicated in the paragraphs led Characters and Tests, which are appended to their e and definition in the Pharmacopœia.

ı the critical examination of any work, the method of edure will be much influenced by the object of study, cially in a work like the Pharmacopœia, which may be ied in connection with the natural classification of the tances yielding medicines, which would be most suitfor the study of materia medica; or, according to their peutic actions, which would be most instructive to the cal student, or according to the nature of the process and physical condition of the product, which is the classifin most advantageous to the pharmacist, and according hich I now propose to treat of the most of its contents in ief a manner as possible, and to notice in detail a few al and a few exceptional cases in each division of my ct.

make no attempt to supersede the Pharmacopœia, and r that my readers should work from the official instruc-, simply accepting my comments as supplementary; I fore do not think it desirable to increase the bulk of this by quoting the Pharmacopœia at length, though the of my remarks will depend greatly upon their being in conjunction with the official text.

ough the number of drugs that are used in powder is t countless, the number of official powders is not large, bly from the facility of extemporizing almost any comion of powders that may be desired. Had our time unlimited, we might profitably have devoted a little tion to powders, simple or compound, which do not r in the official list, but we had probably better confine onsideration at present to the powders of the Pharœia.

Pulvis Amygdalæ Compositus

Contains sweet almonds, 8 oz.; sugar, 4 oz.; gum
1 oz. It is always desirable to use Jordan almond
similarity in shape between sweet Valencia an
almonds, is so great as to risk their occasional mi
even the substitution of the one for the other, a
which could not occur if Jordan almonds were h
used. A few minutes' immersion in hot water, o
maceration in cold, softens and expands the skin
almond, so that it may be easily rubbed off betw
finger and thumb. The shorter the immersion the b
long as the skin becomes soft and loose enough for
If the almonds absorb much moisture, they are more
to powder, and the powder, when obtained, is apt to
mouldy with keeping; consequently, we are instructe
the almonds with a cloth, and if they have been lon
water, it is also better to allow them to dry by exp
the air. The instruction to rub them lightly to a
consistence can scarcely be followed literally if the o
be performed in a mortar. They require beating an
rubbing to reduce them to a smooth, pulpy conditio
is converted into a granular powder by a light rubbin

Pulvis Catechu Compositus.

Catechu	4 oz.
Kino	Each 2 oz.
Rhatany	
Cinnamon	Each 1 oz.
Nutmeg	

In this powder we have 4 oz. of catechu in 10, but as the kino and rhatany are both powerful astringents, we may say that the proportion of active astringents is 8 parts in 10.

There is a direction regarding the preparation of many of the pharmacopœial powders, that they are to be passed through a fine sieve, and finally lightly rubbed in a mortar. The object of this proceeding is to insure the absence of knots of any of the simple powders in the compound. Suppose, for example, that they were all separately kept in stock, finely powdered, and that the catechu had run together into knots, even a long-continued rubbing might fail to make the mixture perfect. Unless recourse were had to sifting there would be little knots of catechu visible in the mixture. These knots would be broken by passing through the sieve, but as the other powders which did not happen to be knotted would pass through more freely, the portion first sifted would contain less than its legitimate quantity of catechu, and the last portion more. A light rubbing in the mortar, however, would suffice to make the sifted product quite uniform.

Pulvis Cinnamomi Compositus,

Also called *pulvis aromaticus*, now contains only cinnamon, cardamoms, and ginger in equal parts—the long pepper which it formerly contained being omitted from the present formula.

Pulvis Cretæ Aromaticus.

Cinnamon	4 oz.
Nutmeg	Each 3 oz.
Saffron	
Cloves	1½ oz.
Cardamoms	1 oz.
Sugar	25 oz.
Chalk	11 oz.

This must not be confused with the last, which is aromatic powder without chalk or sugar. It is also nec sary to observe that it is much more aromatic than the c aromatic confection which it has displaced.

The nutmeg and cloves which it contains are not readi reduced to a fine powder by themselves, unless with the l of a portion of their essential oils, but if rubbed with portion of the sugar, the grinding is facilitated, and the su absorbs the oil. The colour also depends very much upon t mode of operating. If the instructions of the Pharmacop have been literally obeyed, the product is a pale buff powd but manufacturers prefer to see the colour of the saff developed, which is accomplished by rubbing the powde saffron with twice its weight of water, and then adding so of the other powders—in preference the chalk and sugar or and when thoroughly mixed, drying, re-powdering, and las adding the spices. In this way a full bright yellow is p duced. The quality of the powder cannot be judged by colour. This is not even a guide to the proportion of saff it contains, upon which its commercial value greatly res and the medicinal value, which depends upon the aroma and the chalk, is better judged of by its odour and taste.

Pulvis Jalapæ Compositus.

Jalap	5 oz.
Cream of tartar	9 oz.
Ginger	1 oz.

This contains 1 part of jalap in 3; but, unlike the last, the saline adds to its activity both as a purgative and diuretic.

Pulvis Kino Compositus.

Kino	3¾ oz.
Opium	¼ oz.
Cinnamon	1 oz.

This is one of the various compounds in which opium is hidden under the "Co." Besides kino, it contains one-fortieth of opium and one-tenth of cinnamon.

Pulvis Opii Compositus.

Opium	1½ oz.
Black pepper	2 oz.
Ginger	5 oz.
Caraway	6 oz.
Tragacanth.	½ oz.

This contains one-tenth of opium, combined with pepper, ginger, caraway, and a small quantity (one-thirtieth) of tragacanth, which gives it a suitable consistence when mixed with syrup to form a confection. The confection contains so much syrup as to reduce the proportion of opium from one-tenth to about one-fortieth.

Pulvis Rhei Compositus.

Rhubarb	2 oz.
Magnesia	6 oz.
Ginger	1 oz.

This is the rhubarb, magnesia, and ginger so well known under the name of Gregory's Mixture, the proportion of the ingredients, however, being a little varied. The official proportions are—ginger, 1; rhubarb, 2; magnesia, 6. Dr. Gregory's original form was—ginger, 1; rhubarb, 2; magnesia, 8. On the other hand, it is sometimes made with less of the magnesia, viz., in the proportion of 1, 2, and respectively.

This powder is sometimes exceedingly difficult to mix water; this difficulty arises almost entirely from oil in rhubarb forming an insoluble soap with the magne Earthy soaps are exceedingly repellent of water; indeed much so, that many so-called water-proof fabrics dep entirely on their being impregnated with soaps of character for their power to turn the rain. The oil is n legitimate constituent of the rhubarb, but is commonly ad in the grinding to improve the colour and appearanc the powder. The trouble which the pharmacist experie in this particular is a penalty he pays for attaching exaggerated importance to beauty of colour.

Pulvis Scammonii Compositus.

Contains scammony, 4; jalap, 3; ginger, 1. It is sequently one-half scammony. The pure resin is ordered in this case, though it might be used with e advantage. The odour would in that case be different f the preparation with native scammony.

Pulvis Tragacanthæ Compositus.

The comparative value of tragacanth and acacia for aiding suspension may be noted from the fact that tragacanth mucilage of the Pharmacopœia is as viscid as the mucilage of acacia, which contains 32 times as much gum—the former being 1 drachm in 10 ounces, the latter 4 ounces in 10.

Pills.

The pill masses of the Pharmacopœia are in many cases evidently devised with the view of their being divided into 5-grain pills—the dose being usually indicated as 5 to 10 grains; but the proportion of the active constituents is frequently not arranged in any simple numerical relation to 5 grains. Thus a 5-grain compound calomel pill contains 1 grain of calomel and 1 of sulphuret of antimony; gamboge pill contains 1 grain gamboge in 5 of the *dry* materials. So of compound soap pill, there is 1 grain of opium in 5 grains of the *dry* materials—the exact proportion of the active ingredient in a 5-grain pill being interfered with in these two cases by the syrup used in one case and the water in the other, to give the requisite pilular consistence.

There are various masses in which the active ingredient has some other numerical relation. Thus, in the aloetic masses, the proportion of aloes is 2 in 4; in aloes and assafœtida pill, the proportion of each ingredient is 1 in 4 of the mass; in blue pill we have 1 part of mercury in 3 of the mass; in lead and opium pills, the proportion is 1 of opium in 8, and 6 of acetate of lead in 8. In these instances the doses are, of aloes and assafœtida, 5 to 10 grains (though the proportion is 1 in 4); of blue pills, 3 to 8 grains (though the proportion is 1 in 3); and of lead and opium, 3 to 5 grains (though the proportions are 1 and 6 in 8); of aloetic pills, 5 to 10 grains (though the proportion is 2 to 4).

This apparent want of harmony is, however, of no moment, for it is easier to remember the dose of a pill mass than to remember the dose of each ingredient and the proportion contained in the mass.

The most usual excipients are soap, confection of roses, and treacle. Soap is considered advantageous in promoting the solution or emulsifaction of aloes and other resinous drugs. Conserves of roses and treacle have both the property of retaining the mass in a moist condition; the former has the advantage over the latter in giving the mass that species of firm plasticity which enables the pills to retain the shape given to them.

Several of the masses contain essential oils, which are added with the view of correcting the griping tendency of the purgative, or of relieving flatulence. They also impart a characteristic odour. Thus we might recognize the pill of Barbadoes aloes by its odour of caraways, while the pill of socotrine aloes smells of nutmegs; rhubarb pill of peppermint; and colocynth pill of cloves. As a general rule, all the dry ingredients of a pill mass should be separately powdered and mixed together before the excipient is added. There is less certainty of uniformity if the excipient is added before the powders are mixed, and there would be great difficulty in making a smooth, homogeneous mass if a material like aloes or gamboge were added in broken lumps. In some of the pharmacopœial formulæ this mode of pro-condition when first mixed, and that the pills should retain their shape and their solubility, though not necessarily their plasticity.

It is desirable, therefore, that the pharmacist should be allowed a certain small latitude as regards the excipients, provided that the proportion and virtues of the active constituents are not detracted from.

We will now run through the formulæ, noting here and there the object of special modes adopted, or the necessity for precautions not indicated.

Pilula Aloes Barbadensis.

Barbadoes aloes, in powder	2 oz.
Hard soap, in powder	1 oz.
Are to be beaten up with—	
Oil of caraways	1 drm.
Confection of roses	1 oz.

In this case you will observe the dry materials are separately powdered; but mixing before the addition of the excipient is not inculcated, and though advantageous, it is not specially essential in this instance.

Pilula Aloes et Assafœtidæ.

Socotrine aloes, in powder . . .	Each 1 oz.
Assafœtida	
Hard soap, in powder	
Confection of roses	

Beat all together until thoroughly mixed.

Here the aloes and soap are directed to be powdered, but we are left uncertain about the assafœtida. The fact that this gum, when it is dried and powdered, loses much of the essential oil upon which its efficacy depends, points to the conclusion that the massive assafœtida should be used; but the instruction is not so definite as it ought to be, considering the impracticability of getting commercial specimens of assafœtida free from small mechanical impurities, such as fragments of wood, &c., without either straining or powdering and sifting. As I pointed out this want of explicitness to the Pharmacopœia committee before the final revision of their work, I conclude they probably felt the difficulty of deciding to order powdering in all cases when a fine sample of assafœtida would be injured by it, or to order it to be used massive when the commercial drug is not often fit to be so used. Thus we may feel ourselves at liberty to take advantage of the doubt, and according to circumstances proceed one way or the other, as we anticipate we can obtain the best results.

Pilula Aloes et Ferri.

Sulphate of iron	1½ oz.
Barbadoes aloes, in powder . . .	2 oz.
Compound powder of cinnamon . . .	3 oz
Confection of roses	4 oz.

Reduce the sulphate of iron to powder, rub it with the aloes and compound powder of cinnamon, and adding the confection, make the whole into a uniform mass.

Here we have the instructions full and satisfactory, leaving me nothing to add but a passing caution, that powders of crystalloid bodies, such as sulphate of iron, make the pill mass very crumbly unless the salt be very finely powdered, and the mass made rather soft.

It may also be noted that soap cannot be used as an excipient in a mass containing sulphate of iron, &c., as decomposition would ensue.

The purgative action of this pill is greater than might be

Pilula Aloes et Myrrhæ.

Socotrine aloes	2 oz.
Myrrh	1 oz.
Saffron dried	½ oz.
Confection of roses	2½ oz.

Triturate the aloes, myrrh, and saffron together, and sift; then add the confection of roses, and beat them all together into a uniform mass.

his formula gives us occasion to remark upon the use of word "dried." It being the universal custom to dry table substances before they are powdered, it is unneces- to say "saffron dried," except it be to imply that the rh and aloes are not to be dried, because the word is not nded to them.

he aloes is not supposed to be in any way injured by g dried, and can scarcely be powdered in the moist con- n in which it is imported. But the myrrh, if dried, some essential oil in which its medicinal properties (if it any) may be expected to reside; and the process is ably contrived to avoid the drying of the myrrh.

Pilula Aloes Socotrinæ.

Aloes	2 oz.
Soap	1 oz.
Oil of nutmeg	1 drm.
Confection of roses	1 oz.

ery similar to pilula aloes Barbadensis, and requires no ment.

Pilula Assafœtidæ Composita.

Assafœtida	Each 2 oz.
Galbanum	
Myrrh	
Treacle	1 oz

Heat altogether in a water bath, and stir the mass until it assumes a uniform consistence.

n this formula none of the ingredients are directed to be dered, and from the mode of mixing we might conclude it was most desirable to use them in their soft condition trust to their melting; but the myrrh remains so tough under the action of heat and treacle, that it is very diffi to make a smooth mass. It is desirable to powder all gums as fine as possible, avoiding the drying of galban and assafœtida by rubbing them in frosty weather, sifting to remove foreign bodies; the myrrh may powdered at ordinary temperatures, without drying, provi a very fine comminution be not required; but it should used at the same time, as it will agglomerate with keepi The other gums also agglomerate, but as they are m fusible, that is of less moment, though it is most adva tageous, before adding the treacle, to have them all in as fi a state of division as is compatible with their good co dition. The method of mixing ordered for aloes and myr may be adopted with advantage.

Pilula Cambogiæ Composita.

Gamboge, in powder	Each 1 oz
Barbadoes aloes, in powder	
Compound cinnamon, powder	
Hard soap, in powder	2 oz.
Syrup	q.s.

This contains gamboge and Barbadoes aloes, each 1 par about 6 of the mass, the remainder being compound ocynth pulp, but pulp and seeds all powdered to- ınd as the seeds are worthless, and constitute from ls to three-fourths of the whole, it is important to :hey are separated before the colocynth is powdered. lso be noted, in passing, that Barbadoes aloes is used ll, socotrine aloes in the extract; also that scammony ı the pill, and resin of scammony in the extract.

Pilula Colocynthidis et Hyoscyami

2 parts of the colocynth pill, with 1 of extract of It is customary to prepare it with the dry in- ı of the colocynth pill, as the extract of henbane o form a mass with them without any additional

Pilula Conii Composita

extract of hemlock, with one-fifth of its weight of ıha; a sufficient quantity of treacle is also directed led, but with an extract of the usual consistence, any is quite unnecessary.

Pilula Ferri Carbonatis

bstitute for, and an improvement upon, the old d iron pill. The quantity of conserve (one-fourth 'eight of the saccharated carbonate of iron) appears ut is quite sufficient, the sugar in the carbonate it to form a plastic mass with much less excipient uld be required for the same weight of pure car- f iron.

Pilula Ferri Iodidi.

ine iron wire	40 gr.
dine	80 gr.
ıgar	70 gr.
iquorice root powder	140 gr.
istilled water	50 minims.

:ate the iron with the iodine and water in a strong, stoppered ınce phial until the froth becomes white. Pour the liquor upon ıe sugar in a mortar, triturate briskly, and gradually add the ıuorice.

These instructions answer perfectly well if literally obeyed but if ten times the quantity be made at once, there would b some danger, the heat becoming so great as to volatilize bot water and iodine. I have seen a strong 8-ounce bottle bur with a loud report from the violence of the action in makin a similar preparation in about ten times this quantity. Th action in that case, however, was still more violent fro filings having been used instead of wire. The wire i preferable to filings on account of its greater purity. If i were required to produce a larger quantity at a time than he indicated, it would be desirable, after the action had freel commenced, to keep down the temperature by immersing th bottle in cold water till the chance of overheating had ceased and then to promote the completion of the action, whic takes place only slowly in the cold, by raising the water t the boiling point. The sugar retards the oxidation of th iodide of iron, and the liquorice gives the requisite firmnes to the mass. As 80 parts of iodine produce 97·5 of iodide o iron,* the proportion of iodide of iron to the moist mass is in 3½, or 1 in 3 of the dry material.

The solution of iodide of iron should be decanted from th undissolved wire while it is still warm; for in the presence c veniently stiff and crumbly by keeping; its plastic condition may be restored by working it in a mortar, with a very small addition of water, or even, in many cases, without that addition.

There is said to be 1 grain of metallic mercury in a 3-grain blue pill; a small portion, however, is always oxidized. Some pharmacologists attribute the activity of blue pill entirely to the oxide of mercury it contains, and it has been proposed to improve the formula by substituting the black oxide for the metallic mercury. A change of this kind could not be prudently made without very careful investigation. It is not by any means proved that the finely-divided metal is void of activity, or that the black oxide would be so satisfactory in its action as long experience has proved the blue pill to be.

Pilula Hydrargyri Subchloridi Composita.

Subchloride of mercury	Each 1 oz.
Sulphurated antimony	
Guaiacum resin	2 oz.
Castor oil	1 fl. oz.

Triturate the subchloride of mercury with the antimony, then add the guaiacum resin and castor oil, and beat the whole into a uniform mass.

Castor oil is preferred as an excipient in this pill, because it gives adhesiveness and permanent softness.

The pills are apt to become dark with keeping; this is said to result from the calomel forming a black sulphuret of mercury by decomposition with the sulphuret of antimony, a reaction which I have not been able to confirm.

The proportion of calomel is intended to be 1 grain in a 5-grain pill; but as an ounce of castor oil is more than sufficient to make 4 oz. of the powder into a mass, the pills are a trifle stronger. When the mass is made with the view of being divided into pills at once, castor oil is not the most eligible excipient, as the pills remain sticky and unpleasant. The following is an excipient I used for this pill long before castor oil became official, and though I have repeatedly tried the latter, I still give a preference to the mucilage.

*Glycerine Mucilage for Pills.**

Powdered gum tragacanth . . .	3 dr.
Glycerine	9 fl. dr.
Water	4 fl. dr.

Mix the gum and glycerine till smooth before adding the water.

Four ounces of the dry materials require exactly 1 oz. of this mucilage to form a convenient mass, which retains its plastic condition, its solubility, its retentiveness of shape, and a ready miscibility with other aqueous masses, if that were necessary.

Pilula Ipecacuanhæ cum Scillâ.

Compound powder of ipecacuanha . .	3 oz.
Squill in powder	Each 1 oz.
Ammoniacum in powder	
Treacle	q.s.

Mix the powders, and beat into a mass with the treacle.

It is to be observed that this pill is made with compound powder of ipecacuanha, and consequently contains opium. The proportion of treacle required being about 2 oz., there is 14 per cent. of squill and 4·3 per cent. of ipecacuanha and opium.

In the table of opium preparations, the Pharmacopœia states that this pill contains opium in the proportion of "1 in 16½ nearly." This statement would be correct if no

Pilula Rhei Composita.

Rhubarb	3 oz.
Socotrine Aloes	2¼ oz.
Myrrh in powder	Each 1½ oz.
Soap in powder	
Oil of peppermint	1½ fl. dr.
Treacle, by weight	4 oz.

All the dry materials of this mass are directed to be used in powder, and it is the only article in the Pharmacopœia in he preparation of which *powdered* myrrh is used. As it is a ill for which there is a great demand, and is consequently ade in large quantities, the injunction to mix the oil with e powders before adding the treacle is a desirable precauon. The quantity of treacle ordered is rather less than I sually find necessary; this, however, depends partly upon s thickness. I generally find 5 parts instead of 4 to be esirable, in which case the mass contains one-fifth of its eight of rhubarb and one-seventh of aloes.

Glycerine is a good excipient when it is desired to keep is mass soft, but it must be noted that if glycerine alone e used the mass is rather hygroscopic, and the pills become o soft and sticky if not kept in a very dry place, to avoid hich a mixture of 2 parts glycerine with 1 of water or spirit ay be used.

Pilula Saponis Composita.

Opium in powder	½ oz.
Hard soap in powder	2 oz.
Water	q.s.

This contains 1 of opium in 5 of the dry material, or about 1 in 6 of the mass. The propriety of calling it compound soap pill when its activity depends entirely upon the opium, has repeatedly been questioned, but the old name is retained with the view of enabling the physician to prescribe opium without its presence being evident to the patient. Soap is not a good excipient for keeping this mass in a working condition, and for dispensing purposes it may be

kept in better condition by substituting the glycerine mu
lage for a part of the soap and water, thus—

Opium in powder	½ oz.
Soap in powder	1½ oz.
Glycerine mucilage*	1 oz. M

Pilula Scillæ Composita.

Squill in powder	1¼ oz.
Ginger in powder	Each 1 oz.
Ammoniacum in powder . . .	
Hard soap	
Treacle	2 oz., or q.s.

A 5-grain pill contains 1 grain of squill. You may obse
that the Pharmacopœia complicates the statement of the p
portion of squill by saying nearly "1¼ parts in 6."

QUESTIONS FOR EXAMINATION.

What principles should guide you as to whether you shou
make or buy any particular preparation?

What is the object of the mixing ordered to be used af
the sifting of a compound powder?

What is the normal colour of aromatic chalk powde
How does the commercial article differ in appearance, and
the mode of its production?

Sifting a mixed powder, the components of which are not uniformly smooth, may cause a partial separation, and should be followed by a second mixing.

The normal colour of aromatic chalk powder is a dull buff, but with the same composition it is obtained of a yellow colour by the use of moisture in the process.

The friable materials of a pill mass should be powdered and mixed before adding the excipient, that uniform mixture may be more readily obtained.

The excipient of a pill mass may be varied according to whether it be required to be immediately divided into pills, or preserved in the massive state; in the former case a temporary plasticity and permanent solubility must be aimed at; in the latter case it should permanently retain both qualities.

Crystalloids make crumbly masses with ordinary excipients; they should be made soft and worked into pills immediately.

Glycerine is a good addition to many masses when it is desired to keep them plastic, but is too hygroscopic to be used without other excipients.

LECTURE XII.

OFFICIAL LIQUORS OR SOLUTIONS.

Simple Processes—Solutions of Solids—Acetate of Ammonia, &c.—Processes a little more Complex—Solution of Chloride of Antimony, &c.—Solutions of Gases—Solution of Ammonia, &c.

THE LIQUORS OF THE BRITISH PHARMACOPŒIA.

THE preparations coming under this head are very various in their nature. They may be classified according to the mode of their production. First, those in which a solid is added to a liquid, and solution takes place without any further manipulation. In this case the chief point to which I have to draw your attention is the strength of the solution. Then, solutions of solids, the processes for which are of a more complicated character; and lastly, solutions of gases.

l gum, and then the water, is all that is required to give ood result with facility; but if the diffusant be in so small ntity as to moisten the gum only, the use of a mortar mes necessary. The operation may be performed thus:— e half an ounce of powdered gum acacia, 2 drachms of proof it; rub together, and pour in 6 drachms of water. With tant rubbing, a smooth mucilage will be produced in less half the time required if no spirit be used. With tra- nth it is better to use rectified spirit, and to take about achms to each drachm of the gum required, and while e are thoroughly mixed, to pour in the whole of the water full stream, continuing the agitation all the time. There probably few or no cases in which spirit used in these ll quantities could be objectionable, and its presence adds he good keeping qualities of the mucilage.

Liquor Ammoniæ Acetatis.

Acetic acid	1 pint.
Water	5 pints.
Carbonate of ammonia	q.s.

ne ounce of carbonate of ammonia makes a pint of the or; but as 58 parts of carbonate are equivalent to 76 of ate, a pint of the liquor will contain 1⅓ oz. of acetate of nonia. The chief point to be attended to is to get the tion neutral; to ascertain this point satisfactorily a few s may be boiled in a teaspoon to drive off the carbonic before using the litmus paper, because free carbonic acid redden litmus paper to almost the same degree as a ll excess of acetic.

t is a common trade custom to prepare solution of acetate mmonia of greater strength than the British Pharma- eia to save bulk, and dilute the same with the requisite ntity of water at the time of use. However these solutions prepared, they should be compared with a standard to e sure of their not being deficient in strength. I will this comparison with a sample prepared in my own lishment, from a formula calculated to give a solution eight times the usual strength. I take 2 fluid drachms of this solution, and put it into a test-glass with 14 fluid drachms of water, and a little burnt sugar to colour it brown. Into a similar glass I put 2 oz. of solution of acetate of ammonia prepared exactly according to the British Pharmacopœia formula. I now take a glass tube, and dip it to the bottom of the coloured solution, and then close the upper end of the tube with my finger while I carefully transfer it and its contents to the other glass; when the tube touches the bottom of the test-glass I take my finger off the top of the tube, and very steadily draw up the tube, leaving its contents standing like a column of brown smoke in the centre of the clear liquor. After a few seconds the brown column subsides to the bottom, showing that the concentrated liquor was stronger, though scarcely appreciably stronger, than it was calculated to be.

Liquor Ammoniæ Citratis.

Citric acid	3 oz.
Water	1 pint.
Strong solution of ammonia . . .	q.s.

This contains 3 oz. citric acid in about 24 oz. of the liquor, or about 2½ oz. in a pint; but as 4 parts of citric acid yield 5 of citrate of ammonia, there will be a little more than 3 oz.

this solution gradually to the water with agitation after each addition to prevent precipitation, which may take place if the above precaution be not observed. Warm water may be used to avoid this separation; or if it has taken place, re-solution may be effected with heat.

The absence of spirit in the solution of the sulphate is advantageous when it is desired to apply atropia to the eye, as the spirit causes much smarting.

Liquor Morphiæ Acetatis and Liquor Morphiæ Hydrochloratis.

Each contains 4 grains of their respective salts in an ounce, solution being promoted by the addition of a small excess of acid and a little spirit. It must be remembered that the solution, according to the London Pharmacopœia, contains 8 grains to the ounce. It is commonly stated that the present strength corresponds with the strength of laudanum. But according to the Pharmacopœia standard for opium, 100 grains make 3 oz. of tincture, and contain 6 to 8 grains of morphia, which equals 8 to 10 of hydrochlorate (303 parts of morphia being equal to 376 of hydrochlorate), so that 1½ oz. of tincture may be said to equal 1 oz. of liquor as far as regards the *quantity of morphia it contains; but the dose indicated in the Pharmacopœia* would imply the reverse, namely, that 1 part of the tincture is equal to 1½ of the liquor, for they give 5 to 40 minims of laudanum and 10 to 60 of liquor of morphia. If the activity of laudanum depends upon the morphia alone, and the dose of morphia be fixed as above, the dose of laudanum ought to be 15 to 90 minims; but it is impossible to fix in any very definite manner the absolute or relative doses of medicines, an approximation being all that we can look for, and preparations of uncertain strength require, for safety's sake, that the dose should be rather understated; besides which, opium will sometimes contain more morphia than the British Pharmacopœia requires.

Liquor Potassæ Permanganatis

Contains 4 grains of the salt in an ounce of water.

It is better freshly prepared, as it deposits peroxide manganese when long kept, especially if exposed to light, th solution, of course, losing a portion of its active propertie As this change takes place to a greater extent from conta with organic substances, it should not be filtered throu paper, or kept in a bottle stopped with cork.

Liquor Sodæ Arseniatis

Contains 4 grains of the anhydrous salt in an ounce.

Liquor Strychniæ.

An ounce of this liquor contains 4 grains of the alkalo dissolved by the aid of a little hydrochloric acid and spirit.

Strychnia dissolves with still greater facility in acetic ac which might consequently have been used with equal adva tage in preparing its solution.

We will next take sundry solutions which are a little mo complicated in their production.

again evolves sulphide of hydrogen, reconverting the antimony into chloride.

Liquor Arsenicalis.

Arsenious acid	Each 80 gr.
Carbonate of potash	
Tincture of lavender	5 dr.

Water to make a pint.

This contains 4 grains of arsenious acid in 1 oz., dissolved by the aid of carbonate of potash and boiling; the solution takes place only slowly, as the carbonate has not a powerful solvent action.

Liquor Arsenici Hydrochloricus.

Arsenious acid	80 gr.
Hydrochloric acid	2 fl. dr.

Water to make a pint.

This is the same strength as the liquor arsenicalis, and nearly three times the strength of liquor arsenicalis chloridi of the P. L. The old name has been abandoned, as it implied that a chloride of arsenic was formed, which is not at all probable, seeing that if chloride of arsenic be mixed with a bulk of water it is decomposed into arsenious and hydrochloric acids. The liquor, if evaporated, leaves a residue which is not freely soluble in water, and contains but little chlorine. The mode of operating is the same as for the last preparation, continued ebullition being necessary to effect complete solution.

Liquor Bismuthi et Ammoniæ Citratis.

The solution bearing this name officially contains also nitrate of ammonia as a bye-product, the presence of which can scarcely be regarded as advantageous, and may be removed by using the same ingredients and process up to the point of adding the ammonia, but at this stage the solution containing the citric acid, &c., may be divided in half. To one half add ammonia just sufficient to redissolve the precipitate at first formed, then mix this with the reserved half of the

acid solution, and the bismuth from both will be precipitate
It may be collected, drained, pressed, and then diffus
through water, and ammonia added cautiously till solutio
takes place, and lastly, water enough to make up the require
measure. The materials for making one pint are
follows:—

Pure bismuth	430 gr.
Nitric acid	2 fl. oz.
Citric acid	2 oz.
Solution of ammonia	q.s.
Water	q.s.

Liquor Ferri Perchloridi Fortior.

Iron	2 oz.
Hydrochloric acid	12 fl. oz.
Nitric acid	9 fl. dr.

Water, and evaporation, q.s., to make 10 fl. oz.

Iron wire is dissolved in hydrochloric acid to form a prot
chloride of iron, which is next converted into perchloride b
the addition of a further quantity of hydrochloric acid an
a small portion of nitric acid.

The strength of the acids should be ascertained befor
hand; and if they do not come up to the required standar
an increased quantity must be used to compensate for th

own decomposition, but also that which was combined with the protochloride of iron. To avoid the inconvenience of this sudden effervescence, I have adopted the plan of adding protochloride in successive portions to the nitric acid, instead of in the reverse order, as usually pursued. This modification insures the complete oxidation or rather perchloridation of each successive addition of the solution, consequently the NO_2 is never combined, and cannot be suddenly and violently liberated.

The solution is to be evaporated down in a water bath, or otherwise below boiling point, as the salt is liable to decomposition by a brisk ebullition, chloride of iron and hydrochloric acid being volatilized.

The solution, even after evaporation, usually contains a notable quantity of NO_2. Chemically speaking, this is unquestionably an impurity, though it does not affect its medicinal action. If it is desired to avoid the presence of oxide of nitrogen, the protochloride may be formed as in the first stage of the pharmacopœial process, and subsequently converted into perchloride by passing chlorine into it till it no longer produces a blue precipitate with red prussiate of potash. An excess of chlorine would be quite as objectionable as the presence of nitrous compounds, but it is more readily driven off by boiling. Solution of perchloride of iron containing no free acid cannot be boiled without undergoing partial decomposition, hydrochloric acid being given off, leaving peroxide of iron in solution along with the perchloride. By whichever method it be made, it is desirable to have the hydrochloric acid in slight excess. Test-paper cannot be used for indicating the acid, as neutral salts of the heavy metals generally redden litmus, and it is better to regulate the neutrality or excess of acid present by arranging the proportion of materials and the strength of the hydrochloric acid in the first instance; this is the more desirable in the liquor of perchloride of iron, as it has the power of dissolving a considerable quantity of peroxide.

Liquor Ferri Pernitratis.

Iron	1 oz.
Nitric acid	4½ fl. oz.
Water, to make	30 fl. oz.

In this case one portion of nitric acid yields oxygen the iron, while a second retains the oxide in solution. T quantity of nitric acid used is rather more than sufficient both these purposes.

If there is any deficiency of acid, a basic salt is apt to deposited on keeping.

Liquor Ferri Persulphatis.

Sulphate of iron	8 oz.
Sulphuric acid	Each 6 fl. d
Nitric acid	
Water, and evaporation	q.s.

In the preparation of this solution ordinary protosulph of iron is peroxidized by the use of sulphuric and nitric aci the method of operating and the nature of the changes bei similar to those described in the second stage of the prepa tion of liquor of perchloride of iron by the pharmacopo process.

Liquor Hydrargyri Nitratis Acidus.

addition of the chloride of ammonium is to prevent the decomposition of the solution by keeping. A solution of perchloride of mercury exposed to sunshine evolves oxygen and deposits calomel; the presence of hydrochloric acid or chloride of ammonium prevents this decomposition.

Liquor Iodi.

Twenty grains of iodine are dissolved in 1 oz. of water with the aid of 30 grains of iodide of potassium. This is about one-third the strength of the liniment, and about double the strength of the tincture.

The following table affords an instructive comparison of several officinal solutions of iodine.

Iodine being a very powerful drug, it is highly important to discriminate carefully between preparations varying so much.

Comparative Strengths of Solutions of Iodine.

	Iodine in grains.	KI in grains.	Aq. oz.
Liq. iodi, B.P. . . .	20	30	1
„ iodin. co., P.E. . .	8	32	1
„ pot. iodid. co., P.L. .	0¼	0½	1
„ iodin. co., U.S. . .	22	44	1
			Spirit.
Tinct. iodi, B.P.	11	5	1
Linim. iodi, B.P.	55	22	1

Liquor Lithiæ Effervescens—Liquor Potassæ Effervescens—Liquor Sodæ Effervescens.

Lithia water is directed to contain 5 grains in the half-pint bottle. Soda and potash each contains 15 grains. The pharmacopœial instructions are not intended to teach the art of soda-water making, but to fix a definite strength which should always be attended to in waters for medicinal use. The water is directed to be filtered after the carbonate has been dissolved in it, to remove any lime which may have been precipitated. If the lime be not separated by filtration, it is redissolved by the carbonic acid subsequently forced in, and may be detected by the use of oxalate of ammonia.

Liquor Magnesiæ Carbonatis.

Carbonate of magnesia . .	13 gr. in a fl. oz.

Freshly-precipitated carbonate of magnesia is more rea dissolved in an excess of carbonic acid than a carbonate w has been dried, but even the freshly-precipitated salt va according to its physical condition, the lighter precipit being more soluble.

The speed of solution also depends much upon the pres used. The Pharmacopœia does not indicate any partic pressure, but orders the pressure to be continued for twe four hours. A much shorter time is sufficient if a pres of several atmospheres be used.

The solution is ordered to be further charged with carb acid after the excess of magnesia has been separated; excess of acid in great measure covers the bitterness of salt, and tends to preserve it in solution. The stren indicated is greater than I have found in commerce, greater than can be kept without considerable deposit tak place.

Liquor Plumbi Subacetatis.

Acetate of lead	5 oz.
Oxide of lead	3½ oz.

better therefore to prepare it fresh when wanted, and, if practicable, to use distilled water which has been boiled to expel carbonic acid, and cooled out of contact with the air.

Liquor Potassæ—Liquor Sodæ.

Potash hydrate.	27 gr. in 1 fl. oz.
Soda hydrate	18·8 gr. in 1 fl. oz.

These preparations are made by boiling the carbonates of the alkalies with hydrate of lime in an iron pan, and decanting the liquor without filtering. Tin, copper, lead, or enamelled pans are acted upon by the caustic alkalies, and should be avoided.

As these liquors also act upon filtering paper and cloth, subsidence is preferred to filtration for the separation of the lime; their great affinity for carbonic acid necessitates their being kept in well-closed vessels, and as lead glass is more attacked by them than hard green glass, the latter is prescribed for their preservation. The boiling promotes the complete decomposition of the alkaline carbonates and the subsidence of the carbonate of lime, but also increases the solvent action of the alkali upon silica or alumina which may be present in the limestone, thus introducing them as impurities in the liquor. In making 1 gallon, 1 pound of carbonate of potash, or 28 oz. of carbonate of soda, is used; yet the liquor of potash is nearly one-half stronger, as the potash salt only contains about 16 per cent. of water, while the carbonate of soda, having 10 equivalents of water of crystallization, is about two-thirds water.

Liquor Zinci Chloridi.

Zinc	16 oz.
Hydrochloric acid	44 fl. oz.
Water	20 oz.
Chlorine	Each q.s.
Carbonate of zinc	
Evaporation	

To make 2 pints.

A concentrated solution of chloride of zinc is obtained by digesting zinc in a quantity of hydrochloric acid, insufficient

to dissolve the whole of it. Towards the close of the pro
it is boiled to effect the combination of the last portion
acid, and to reprecipitate copper or any of the more elec
negative metals which may have been dissolved while
acid was in large excess. As iron is not separated in
way, the solution is filtered off and subsequently treated w
chlorine, by which any protochloride of iron in solution
converted into perchloride (an odour of free chlorine indic
ing that the action is complete); in this condition it is read
precipitated by double decomposition with carbonate of z
which is added in successive portions till it ceases to thr
down any more peroxide of iron. After a second filtrati
the liquor is evaporated in a porcelain or stoneware basin,
which means any free chlorine is driven off, and the bulk
reduced to the required standard.

Forty-four fluid ounces of hydrochloric acid, sp. gr. 1·
equal 51 oz. by weight, and containing 31·8 per cent.
HCl, the weight of real acid is 16 oz., and as

$$\begin{array}{ccccccc} \text{HCl} & & \text{HCl} & & \text{Zn.} & & \text{Zn.} \\ 36{\cdot}5 & : & 16 & :: & 32{\cdot}5 & : & 14{\cdot}24 \end{array}$$

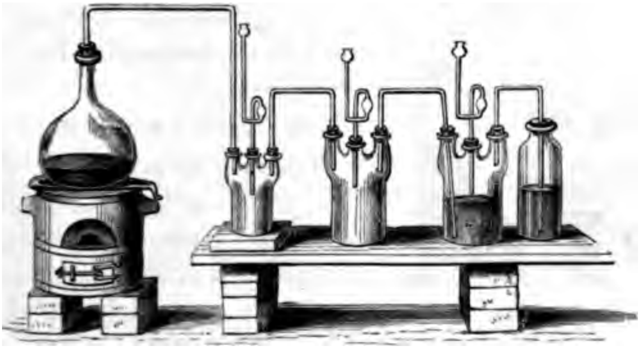
the quantity of zinc which should be dissolved. There
thus 1¾ oz. of zinc in excess to allow for the impurit

carbonate of zinc which gives any indication of iron at all probably precipitates all that is present; but if the same method be used for the separation of iron from zinc when the former is present in larger proportion, it is necessary to add successive portions of the carbonate of zinc till it no longer precipitates iron.

Liquor Ammoniæ—Liquor Ammoniæ Fortior—Liquor Chlori—Liquor Sodæ Chloratæ.

These four solutions may be grouped together as depending for their formation upon the passage of gases through watery fluids at ordinary pressure and temperature. The ammoniacal liquors are by far the most important of the group; but as they are never made by the retail pharmacist, it is not necessary that we should devote much time to their consideration. The chief points of interest to us are to see that the solutions are of the requisite strength and purity. The gas is apt to carry over some mechanical impurities, which are deposited along with water and ammonia in the two first bottles (see Fig. 34), which take the place of the washing bottles generally interposed between a gas generator and condenser. The extreme solubility of ammonia would risk

Fig. 34.

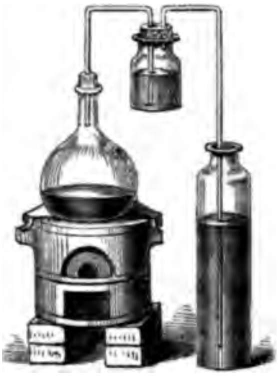


Liquor Ammoniæ Fortior, B.P.

the contents of the washing bottle being carried back into the generator, or, with a rapid evolution of gas, being carried forward into the condensing bottles. The two empty Woulff's bottles through which it passes serve also to cool the ammonia by which its solution is promoted. The third bottle is supplied with distilled water, and is sometimes immersed in a tub of cold water to remove the heat, which is liberated in considerable abundance, as the gaseous ammonia becomes liquid by solution.

Chlorine being much less soluble, is passed from the generating flask through a washing bottle, and then direct into the water or solution of carbonate of soda required to make the respective liquors. The flask (Fig. 35) contains black oxide of manganese and hydrochloric acid, the decomposition being as follows—

Fig. 35.



Liquor Sodæ Chloratæ, B.P.

$$MnO_2 + 2\,HCl = MnCl + H_2O + Cl.$$

The chlorine carries over with it a portion of hydrochloric acid, and some mechanically attached chloride and oxide of manganese, which are removed by the wash-

QUESTIONS FOR EXAMINATION.

What rules are observed regarding the strength of some of the official solutions?

What are some of the most notable exceptions?

What objection is there to the present formula for solution of carbonate of magnesia?

What precautions against the introduction of impurities are to be observed in the preparation and preservation of the solutions of the caustic alkalies?

In what respect might the instructions regarding the purification of chloride of zinc be modified with advantage?

RECAPITULATION.

Solutions of drugs which have not any great activity are of very various strengths. Solutions of alkaloids and sundry other very potent drugs are prepared in the proportion of 4 grains of the solid to 1 oz. of the liquor. Solution of perchloride of mercury is a conspicuous exception to this rule, its strength being ½ grain in 1 oz. The solution of iodine is another notable exception, its strength being 20 grains in 1 oz.

The solution of carbonate of magnesia is difficult to obtain of the standard strength, and more difficult to preserve of that strength.

The solutions of the caustic alkalies require caution to avoid their contamination with the material of the utensils in which they are prepared or preserved.

The official instructions for separating iron from chloride of zinc require a slight modification if the iron be present in considerable proportion; in the latter case say, "Add carbonate of zinc till it no longer precipitates oxide of iron."

LECTURE XIII.

OFFICIAL INFUSIONS AND DECOCTIONS.

Cases in which Infusion is preferred—Keeping Qualities of Infusions—Rules for Infusing—Temperature Varies—Time Varies—Comminuti Varies—Decoctions, when preferred—General Rule and Exceptions—Decoctions of Aloes, Cinchona, Logwood, &c.—Sarsaparilla.

THE group of pharmaceutical products for our prese study includes most of the pharmacopœial preparations i which the soluble part of a vegetable material is held i solution by water for use, while the insoluble and commonl inert matter is rejected.

The process of infusion is generally preferred in such cas where it is desired to extract volatile as well as fixed matte Thus, chamomile contains a volatile oil which would l

The chief points to be attended to in making the official infusions are—

1. The exact temperature ordered.
2. The exact time, neither more nor less.
3. The infusion should be drained off without pressure.
4. The ingredients should be in a suitable state of comminution.
5. They should be stirred or suspended in the water, so as not to lie at the bottom all the time.
6. The ingredients of a compound infusion should each be weighed separately, not kept mixed in bulk.

Most of the infusions are made with boiling water, the exceptions being calumba and quassia, which are made with cold water, and chiretta and cusparia with water at 120° Fahr. (= 48·8° C.).

The temperature of 212° Fahr. (= 100° C.) coagulates vegetable albumen, if such be contained in the herb under operation; it also dissolves starch, which would not be taken up by cold water. The temperature of 120° Fahr. does not act upon the starch, and does not coagulate the albumen. We cannot always determine, on theoretical grounds, the most suitable temperature for any given infusion, the result being ultimately determined by experience.

The time required varies from a quarter of an hour to four hours; and, as I said with regard to temperature, I cannot point out theoretical grounds upon which the length of infusion could be determined; but I may note in passing, that it has recently been stated that the time of infusing may be reduced to one-half its present length without any loss of quality.

It is obvious that too short a maceration would imperfectly extract the active matters; but it may not be so readily perceived that too long a maceration may injure the product by dissolving an excess of mucilaginous matter, and this will be present in still larger proportion if the residue be pressed to get off the last portions of the infusion. The experiment may be tried on infusion aurantii and infusion rhei.

The infusions to be macerated a quarter of an hour are four in number, viz., anthemidis, aurantii, aurant. compositum, and cusco. Those to be macerated for half an hour are seven, viz., caryophylli, catechu, chiratæ, ergotæ, maticæ, quassiæ, and rosæ. For one hour there are ten, viz., buchu, calumbæ, cascarillæ, digitalis, dulcamaræ, gentianæ compositum, krameriæ, rhei, senegæ, and sennæ. The infusions macerated two hours are six in number, viz., cinchona, cuspariæ, lupuli, serpentariæ, uva ursi, and valerianæ. Four hours' maceration is only ordered in one case, viz., infusion lini, and it is worthy of note that this is the only infusion which depends for its value solely upon the colloid matter it contains.

The degree of comminution is in most cases loosely defined, though the present is an improvement upon previous Pharmacopœias in that respect. Leaves and flowers do not generally require any comminution. Buchu is an exception to this rule, the varnish-like surface of the leaves rendering them almost impervious to moisture. The former instruction was to macerate the entire leaves for four hours; the leaves now being bruised, one hour's maceration yields an equally strong inoft roots and herbs are usually directed to be cut small; is quite sufficient in the case of orange-peel, calumba root, etta, matico, &c.

degree of comminution between these two is indicated for tany, senega, &c., by the word "bruised," which may be sidered to express such a condition as would pass through ddle having perforations of one-sixth to one-fourth of an diameter.

nfusions which have been allowed to macerate without ring, may be observed to be much darker at the bottom contact with the vegetable matter, therefore occasional ring should always be had recourse to during the maceration, ess the materials are supported in the upper part of the sion pot in such a way as to allow of the water circulating ough them.

have already pointed out, in speaking of comminution, t several ingredients, mixed together in a rough and unequal te of division, could not be depended upon for remaining formly mixed, and I need now only draw your attention in to the fact that, if the ingredients for compound infusion gentian or orange-peel be kept ready for use, they should be mixed in bulk, but each ingredient weighed separately packets, each packet being enough for a single operation, sufficient for a pint, or a quart, or a gallon of infusion.

The decoctions are aqueous preparations of such vegetables are not quickly spoiled by heat, and do not very readily d their active principles to cold or warm water; there is haps, in some cases, no very strong reason for the selection he one process in preference to the other.

he instructions for making decoctions are now much more sfactory than they were in some of the former Pharmaœias, the duration of the boiling being much reduced, and at same time being made more uniform, the product being made of uniform quantity by the addition of water to ke up for what has been volatilized; so that the time and quantity are now both definite, excepting in the single instance of decoction of pomegranate root, in which 2 pints of water are to be placed upon 2 oz. of the root, and boiled down to a pint, without regard being had to the longer or shorter time that it may require.

The general rule is to put on a pint of cold water, bring it to the boil, and let it boil gently for ten minutes, afterwards percolating as much water through the residue as makes the product measure a pint. There are several exceptions to this rule ; for instance, decoctions of poppy and sarsaparilla have a pint and a half of water used in the first instance to produce a pint of the ultimate product.

In the case of sarsaparilla *boiling* water is poured upon the sarsaparilla, and an hour's maceration precedes the making of the decoction. The decoction of aloes, on the other hand, is macerated two hours after boiling before it is strained.

There are a few of the decoctions which require to be noticed a little more in detail.

Decoctum Aloes Compositum.

This is one of the most important decoctions in the Pharmacopoeia.

It may be said to contain 4 grains of aqueous extract of

. This deposit is said to be inert; it should be separated ubsidence and decantation, as its slimy nature makes it er difficult to filter. The saffron is only added after the ng, but before the cooling. It is a common trade custom repare decoction of aloes four times the pharmacopœial igth, it being stated that 1 part of the concentrated decoc- mixed with 3 of water makes the decoction of the British rmacopœia. This, however, cannot possibly be the case, ne quantity of tincture of cardamoms would have to be z., while the whole product would be only 30. It is impossible that decoction of aloes might be improved, ably by its becoming an infusion in cold water or te spirit instead of a decoction; but such questions are ter for the study and experiments of the authors of the rmacopœia, and whatever opinion we hold upon them, we not justified in using as decoction of aloes any prepara- but that made by the official formula.

Decoctum Cinchonæ Flavæ.

Yellow bark	¼ oz.
Water	1 pint.

n ounce of this decoction is intended to contain the ble matter of about 30 grains of bark. The decoction was nerly ordered to be strained while hot, it being supposed the deposit which takes place on cooling contained alka- s; but a closer examination having proved that it was inert, resinous, and colouring matters, it is now directed e strained cold, by which its appearance at least is roved.

inchona bark yields its alkaloids to water with consider- difficulty, especially if in coarse powder, the official pro- not extracting one-half of its active principles. There no preparations from cinchona that can be considered sfactory in a commercial point of view except the alka- s, and if there is any ground for desiring any galenical resentative of its entire activity, there is yet room for rovement.

Decoctum Hæmatoxyli—Decoctum Granati—Decoctum Quercus.

In preparing these and other astringent decoctions, care must be taken to guard against their becoming blackened by contact with the pan if that be of iron. It is said, and I believe with some truth, that imperfectly tinned vessels are more likely to cause discoloration than clean iron, and that liquors may be boiled in an iron pan without injury, which would be blackened if allowed to cool in the same.

Decoction of logwood is very apt to get an inky tint from a very small contamination with iron; its colour is also very sensitive to the action of various other chemicals; not only will alum and iron salts deepen it, but even the carbonate of lime contained in many hard waters will make a visible change in its tint. This change will be seen the more readily, for experiment, if you pour a few drops of the decoction into a glass of distilled water, and the same quantity into another glass containing water which is hard from holding carbonate of lime in solution.

Decoctum Sarsæ Compositum.

Jamaica sarsaparilla is the only kind acknowledged offi-

What materials require fine comminution for making infusions and decoctions?

In what respect must the official decoction of aloes be essentially different from a concentrated decoction diluted with water?

What precaution is necessary in making astringent decoctions?

What kind of comminution should sarsaparilla root be subjected to in preparation for boiling, and what difference in the decoction results from the various modes of its division?

RECAPITULATION.

Infusing is preferred to boiling for the extraction of drugs which contain valuable volatile matter, or are easily injured by heat.

The time required for infusion is determined by the compactness of the material, and the difficulty with which its active constituent is dissolved.

Essential oils improve the keeping qualities of infusions; mucilaginous and albuminous matters detract from the same.

Porous substances only require coarse comminution; hard barks should be finely divided.

Decoctions are preferred of such drugs as are difficult to exhaust, and are not easily injured by heat.

Concentrated decoction of aloes cannot be prepared to yield on dilution with water a fair representation of the official product.

The official process for decoction of cinchona only extracts about half the alkaloids present.

Astringent decoctions require care to avoid discoloration by the action of iron, &c.

LECTURE XIV.

EXTRACTS.

Varieties—General Process for Green Extracts—Extracts by Aq Infusion—By Decoction—Aqueous Fluid Extracts—Liquors of O Deane and Brady's, Battley's—Extracts prepared with Spirit and —Alcoholic Extracts—Ethereal Extracts.

THE extracts constitute a class of preparations very portant in pharmacy, and of considerable diversity bot the nature of the process and of its product. The proc include infusion, decoction, percolation, expression, eva tion, distillation, &c., and the product is either a flui semi-solid, a hard mass, or a powder. They all agree, ever, in being prepared in the fluid state first, thus natu following the subject of my last lecture on infusions obtained is heated without loss of time to 130° Fahr. (= 54·4° C.), by which the green colouring matter separates; the liquor is then strained, the colouring matter being reserved to add to the extract at a later stage; the heat of the clear liquor is raised to 200° Fahr. (= 93·3 C.), by which the albumen coagulates, and is separated by a second filtration and rejected, it being found that the albumen promotes the decomposition of the extract if not separated.

The clear liquor is then evaporated till of a syrupy consistence, a water bath being used to avoid the risk of injury by over heating. The temperature of a liquid freely evaporating in a water bath is always a few degrees below boiling point, generally as many as 20° or 30° Fahr. at the beginning of he process, but approaching more closely as the viscidity of he liquid increases. The extracts of colchicum and taraxa-um are to be evaporated in a water bath at a temperature ot exceeding 160° Fahr. (= 71·1° C.), but in the other cases he use of the water bath without this restriction of tempera-ure is considered to give sufficient protection against injuries y heat until the syrupy consistence has been attained, at hich point the green colouring matter first separated is lded to the liquor, and the evaporation continued at a heat hich is now to be regulated both by the bath and the ermometer, and is not to exceed 140° Fahr. (=60° C.). The green colouring matter is found to give the extract a tter consistence than it would otherwise have, and keep in a better condition. The ultimate consistence of the tract should be a rather soft pilular condition; but it is not und practicable to fix very definitely the consistence; some tracts are apt to become hard by keeping, others, if evapo-ted to a firm consistence, reabsorb moisture. This is the se with the extracts of colchicum and taraxacum, while tracts of lettuce, aloes, logwood, and sarsaparilla have the pposite tendency. As a rule it is most desirable to have tracts reduced to that condition which leaves little tendency ither to absorb or to lose moisture by ordinary keeping.

The extracts prepared by this method are aconite, belladonna, hemlock, henbane, and lettuce from the green herb, and colchicum and taraxacum from the corm and root; the two latter being parts of the plant which do not contain chlorophyll, the first filtration is not required.

The groups of watery extracts may be divided according to the mode of procedure; thus the extracts of aloes are produced by hot infusion; opium, calumba, and liquorice, by cold infusion. By hot percolation we have—extracts of poppy and pareira; by cold percolation—rhatany, quassia; by boiling—chamomile, gentian, logwood.

Extractum Aloes Barbadensis—Extractum Aloes Socotrinæ.

The aloes being dissolved in hot water, allowed to cool and settle, the soluble portion is separated and evaporated to dryness in a water bath. It must not be supposed, however, that the aqueous extract thus obtained is entirely soluble in water, for the extract undergoes some change during the evaporation by which a portion is rendered insoluble, and however often the solution, filtration, and evaporation are repeated, this always continues to be the case. I have myself repeated the process till there was only 3½ per cent.

Extractum Glycyrrhizæ

Is also prepared by repeated macerations in cold water alternated with pressure. The use of the press in this and similar cases is very important, as it enables the exhaustion to be completed in much less time and with much less liquor, thus saving evaporation and improving the flavour.

Extractum Opii.

The opium is macerated in successive portions of hot water, the liquors filtered off, and evaporated to a pilular consistence. It yields about half the weight of the original opium, and as it contains nearly the whole of the active matters it is double the strength of the crude drug. It is also to be noticed that the extract is free from the earthy odour which is so characteristic of opium and its tincture. Most drugs lose a portion of their medicinal activity during drying or the evaporation of their extracts; opium, under these circumstances, loses narcotine, but it is said that the morphia is not diminished.

Extractum Papaveris—Extractum Pareiræ.

These two drugs are exhausted by infusing in hot water, and afterwards percolating more hot water. They should not be in a very coarse state, or the percolation is too rapid. It is to be noted that the poppy seeds are to be removed from the capsules, the seeds being oily, mucilaginous, and nearly, if not quite, inert.

Extractum Krameriæ—Extractum Quassiæ.

These extracts are prepared by infusing the roughly-powdered drugs in cold water, and afterwards percolating cold water till exhaustion is effected, the liquors being evaporated in a water bath. The extract of rhatany is to be reduced to dryness, the quassia to the usual pilular consistence.

Extractum Anthemidis—Extractum Gentianæ.

In the preparation of these two extracts we have recourse to actual boiling of the ingredients; in the case of gentian

the boiling being preceded by a couple of hours' infusin
Chamomile contains an essential oil which is dissipated
the process, but its loss is compensated for by the addition
oil of chamomile at the end of the evaporation.

Extract of Logwood

Is evaporated to dryness in copper or enamelled vessels, t
contact of iron being avoided on account of the blackne
which it occasions.

AQUEOUS FLUID EXTRACTS.

The aqueous fluid extracts are—bael, cinchona, erg
opium, pareira, and sarsaparilla.

The processes for these preparations are very similar
those for the firm extracts, except that the liquors are ev
porated down to a given measure, or to a given density, a
spirit is added to prevent mouldiness or fermentation.

Extractum Belæ Liquidum.

One pound of bael fruit is macerated in successive portions
water, and the liquors evaporated till they measure 14 flu

solvents has been adopted for extracting ergot, but with questionable advantage, though the physiological action of ammonia may give valuable assistance to that of ergot.

Extractum Opii Liquidum.

This is prepared by dissolving 1 oz. of *extract* of opium in 16 oz. of water, and adding 4 oz. rectified spirit. Though the extract of opium was a perfect solution before it was evaporated, it does not now perfectly redissolve.

This may be regarded as an official liquor to take the place of a number of liquors of opium which have enjoyed more or less popularity since the first introduction of Battley's sedative solution of opium. The general fault of all these preparations is that they aim at a definite relationship between the finished product and the crude drug from which it was prepared, whereas the more satisfactory standard would be in relation to the morphia which constitutes its most important active principle. This point will be further treated under the pharmacy of opium in a subsequent lecture. Battley's Paper appeared in the *Pharmaceutical Journal* for 1850.

Extractum Cinchonæ Flavæ Liquidum.

The Pharmacopœia process for this preparation may be considered a modification of Battley's, as the powdered bark is macerated in a little more than double its weight of water, and then exhausted by the percolation of more cold water. The subsequent evaporation is continued till a specific gravity of 1·2 is obtained, as Battley directs, and then spirit added in such quantity as to reduce the gravity to 1·1.

According to my own experience, it is impossible to obtain even an approach to a satisfactory exhaustion of the bark by the percolation of 12 pints of water through 1 lb. of the cinchona, even when very finely powdered.

This will be further treated under the pharmacy of cinchona; at present I have only to add that 4 oz. of the liquid extract are supposed to represent 1 lb. of the bark, but ma more correctly be stated to represent that portion of th active matter of a pound of bark which is readily solub in water, and not rendered insoluble by the subsequen evaporation.

Extractum Pareiræ Liquidum

Is prepared, like the solid extract, by hot percolation, and evaporated so that 1 lb. of the fluid extract shall represen 1 lb. of the root.

Extractum Sarsæ Liquidum.

In this instance the water is used at 160° Fahr. The roo is cut transversely, but not split, that the starch may not b so much dissolved; two macerations are used in the place o percolation; the evaporation is continued till a specific gravit of 1·13 is attained, and spirit subsequently added. It i expected that 1 lb. of sarsaparilla will yield 8 fluid oz. o extract, but the density being fixed is a protection against th root or the process being at fault, as in that case the quantit rather than the quality would suffer.

In commercial samples, it must be remembered that th density is not in itself an indication of correct strength, as i till a pilular consistence is attained. The activity of the extract depends almost exclusively upon the alcoholic portion —the mucilaginous matter extracted by the water being useful mainly as an excipient for retaining the jalap resins in an emulsable or diffusible condition.

Extract of hops is prepared by the same method; but extract of rhubarb is obtained by acting on the root with spirit and water mixed, the spirit being one-tenth the quantity of the water.

The quantity of spirit used in extracting the hops is very small compared to the bulk of the material operated upon, and a powerful pressure is necessary to press out of the hops a satisfactory proportion of the pint and a half of spirit used.

ALCOHOLIC EXTRACTS.

Extractum Cannabis Indicæ—Extractum Colocynthidis Compositum—Extractum Nucis Vomicæ—Extractum Physostigmatis—Extractum Stramonii.

Hemp, nux, Calabar, and stramonium form a group. Hemp is simply macerated with spirit, nux is boiled with spirit, Calabar bean is macerated and percolated, and stramonium is percolated with spirit after having had its essential oil removed by percolation with ether. It is correctly classed with the alcoholic extracts, and not with the ethereal, as the matter extracted by the ether does not enter into the extract ultimately formed.

In the processes with spirit and ether, it is desirable to economize these valuable solvents by having recourse to distillation instead of evaporation in an open vessel, the still body being heated by a water bath to avoid scorching, and the distillation continued till a syrupy liquid is obtained, the completion of the evaporation being effected in an open pan heated by water, the evaporation of the last portion of spirit taking place more rapidly, and at a lower temperature, in an open pan than in the close still body.

Extractum Colocynthidis Compositum.

Colocynth *pulp*	6 oz.
Extract of socotrine aloes	12 oz.
Resin of scammony	4 oz.
Soap	3 oz.
Cardamoms	1 oz.
Proof spirit	1 gal.

This is the most popular extract in the Pharmacopœ though it might more appropriately have been called colocyn pill, had that name not been already allotted to a differe compound. The colocynth pulp is exhausted by being mac rated in *proof* spirit for four days (all the other alcoho extracts being made with *rectified* spirit); then this pro spirit tincture is submitted to distillation till the spirit h come over, leaving the extract of colocynth in combinati with a watery liquid containing but little spirit, and to this i added the extract of aloes, resin of scammony, and soap; a then the evaporation is continued till a pilular consisten is obtained, the powdered cardamoms not being added towards the end of the process that their aroma may n be lost by the continued action of heat. There are few the extracts which are conveniently kept of a firm pilu is used, and that aqueous *extract* of aloes and *resin* ıony are directed.

ETHEREAL EXTRACTS.

ım Filicis Liquidum—Extractum Mezerei Æthereum.

rmer of these is a purely ethereal extract, and the extract obtained by the action of ether upon an extract. The mezereon bark being extracted by ɔn with successive portions of spirit, the bulk of the stilled off, and the residue evaporated to a soft he ether is then added, which takes up only a porhe matter soluble in alcohol; the ethereal solution listilled, and at last evaporated to a soft extract. king extract of male fern the ether is made to percough the root in powder, and to economize ether, a ntrived upon such a principle that the same portion is percolated, distilled, and re-percolated any number

QUESTIONS FOR EXAMINATION.

be in outline the process for extracts prepared from rbs.

precautions are used in the evaporation of the liquors cts?

varieties of physical condition do the official extracts

kind of change commonly results from evaporation, t drug is said to be an exception to the rule?

two extracts are prepared from fruits from which s are first to be separated?

ıs sarsaparilla root divided in preparation for making and why is the old custom discontinued?

h two extracts are prepared by making alcoholic and extracts separately, and then combining them?

RECAPITULATION.

The extracts are vegetable preparations, liquid in
stage of the process, and concentrated by evaporat
denser liquid, a plastic mass, or a friable solid.

The aqueous liquors, more especially from gre
should be evaporated with as little loss of time a
patible with a safe temperature; a water bath is
used, and the heat also regulated by the thermo

Most vegetables lose part of their activity by dry
most vegetable liquors lose value during evaporatio
is said to be an exception to that rule.

Extract of colocynth should be prepared from th
the fruit only, the rind and seeds being first separate

LECTURE XV.

SPIRITS, TINCTURES, WINES, VINEGARS, LINIMENTS.

Spirit of Wine—Official Spirits not Redistilled—Tinctures—Various Wines—Sherry and Orange—Medicated Vinegars—Liniments—Aconite and Belladonna—Sundry Liniments.

THE study of this group of liquids most appropriately commences with a few remarks upon spirit of wine. It is unnecessary to enter into its chemical history; but the customary modes of expressing its strength in commercial parlance, and the rules for converting one strength into others, must claim a little attention.

Spiritus Rectificatus.

Alcohol with 16 per cent. of water, known in commerce as pirit of wine, 56 O.P., its specific gravity being, according the British Pharmacopœia, ·838. The principal points of terest to us at the present time are the relation between the rength and gravity, and the modes of converting spirit of one rength to other standards. I will not attempt to enter fully to the matter, but must notice that the Excise standards are rectified spirit of 63 O.P. It is known for Excise purposes standard alcohol, sp. gr. ·825, and contains about 89 per nt. of absolute alcohol. The second standard is known as oof spirit; its specific gravity is ·920, and contains 48·5 alcohol. Any strong spirit is reduced to proof by adding ter till 100 measures become 100 plus the number over of of the sample before dilution. This takes a number of measures of water a little greater than the number over proof, as a slight condensation takes place on dilution. Thus, if we take the "standard alcohol" of the Excise—that is, spirit 63 O.P.—we shall have to add water to 100 measures of spirit till it becomes 163 measures at 60° Fahr. to reduce it to proof spirit. The reason for this arrangement is very evident, the duty being fixed at so much per gallon on proof spirit; the scale on the hydrometer is constructed so as to indicate any number over proof; it makes a very simple calculation to ascertain what duty is chargeable upon the strong spirit. Thus, with spirit of the strength I have supposed, the number of the gallons is to be multiplied by 1·63, to give the number of gallons of proof spirit to which it is equal, and consequently by multiplying this by the duty, the payment upon the whole is indicated; and if the strength were 54 O.P., the number of gallons would be multiplied by 1·54 with the same object. And for our pharmaceutical purposes, if we have to reduce the spirit of 54 O.P. to proof, we add water till one gallon measures 1·54, and so on, of any other strength.

The official rectified spirit has a specific gravity of ·838, or, by the Excise rule, is 56 O.P., and the instruction for its

r of gallons of proof spirit contained in 8 gallons
.

ement which is current, that 20 U.P. spirit requires n of 20 measures of standard alcohol to 100 measures of proof strength, would be nearly correct if we absolute alcohol for standard alcohol, or would be ut by saying, to 100 measures of 20 U.P. spirit add standard alcohol as would make 20 measures of proof spirit.

lowing table shows the percentage of alcohol, and definitions applicable to spirits of various specific

—

Per cent. Alcohol.	
1	98 U.P.
3½	95 „
5	91 „
7	85 „
10	80 „
15	72 „
17	66 „
20	59 „
23	54 „
25	50 „
27	45 „
30	38 „
33½	31 „
35	27 „
37¼	23 „
40	18 „
43	12 „
45	8½ „
47	5 „
49	Proof.
50	½ O.P.

Sp. Gr.	Per cent. Alcohol.	
·914	51½	5 O.P.
·9069	55	10½ „
·900	58	15 „
·8956	60	19¼ „
·890	62	24 „
·8840	65	28 „
·876	68	34 „
·8721	70	38 „
·868	71¼	40 „
·8603	75	45 „
·852	78½	48 „
·8483	80	50 „
·842	82½	54 „
·838	84	56 { B.P. Rect. Spirit.
·8357	85	57 „
·825	89	63 „
·8228	90	
·8172	92	
·8089	95	
·8031	97	
·7938	100	

common in foreign formulæ, and in chemical other naceutical writings, to express the strength of spirit ages of alcohol, the following rule will be found reducing rectified spirit to lower strengths. As ntage of rectified spirit is to the percentage of the uired, so is 100 to the quantity of rectified spirit which will make 100 of the percentage required. To ma 100 oz. of alcohol of 74 per cent. from rectified spirit (84 p cent. alcohol), say—

$$84 : 74 :: 100 : 88,$$

therefore take 88 parts by weight of rectified spirit and a water to make 100, and it will be of the required strength; if a fractional measure of the 74 per cent. spirit be requir say 7½ oz., take the last term of the proportion as a decin and multiply by 7½ thus:—

$$0{\cdot}88 \times 7{\cdot}5 = 6{\cdot}6,$$

that is the weight of rectified spirit required to make 7·5 by weight of 74 per cent. alcohol.

SPIRITS OR ALCOHOLIC SOLUTIONS, such as do not invo the use of distillation, may be considered next. They are—

Spirit of ether .	. 1 fl. oz. of ether	to 2 fl. oz.	of rectified spiri
,, cajeput .	. 1 fl. oz. of oil	to 49 fl. oz.	,,
,, camphor .	. 1 oz.	to 9 fl. oz.	,,
,, chloroform	. 1 fl. oz.	to 49 fl. oz.	,,
,, juniper .	. 1 fl. oz. of oil	to 49 fl. oz.	,,
,, lavender .	. 1 fl. oz. ,,	to 49 fl. oz.	,,
,, peppermint	. 1 fl. oz. ,,	to 49 fl. oz.	,,
,, nutmeg .	. 1 fl. oz. ,,	to 49 fl. oz.	,,
,, rosemary .	. 1 fl. oz. ,,	to 49 fl. oz.	,,
Essence of aniseed.	. 1 fl. oz. ,,	to 4 fl. oz.	,,

simply corresponds to the smaller percentage of chloroform which it contains.

The old chloric ether was prepared by distilling spirit with chloride of lime in an insufficient quantity to decompose all the spirit, part being converted into chloroform, and part being distilled unchanged. These compounds must not be confounded with chloride of ethyl, known as hydrochloric ether, or with the substitution products obtained by passing chlorine into ether, and known under the names of dichlorinated and trichlorinated ethers.

TINCTURES.

Having spoken at some length upon the phenomena of diffusion of liquids in one lecture, and upon percolation in another, we shall have at present comparatively little to study under this head, except the composition, the proportion of active matters, and a few exceptional cases.

Tinctura Aconiti.

Two and a half ounces of the root in coarse powder is macerated in 15 oz. of rectified spirit for forty-eight hours, with agitation; the whole is then placed in a percolator, and when the spirit has drained through, 5 oz. more spirit are percolated; the marc is pressed; the liquors obtained by percolation and expression being all mixed, as much more spirit is added as is required to make the whole measure a pint.

This may be considered a typical process, several others being exactly the same, and a larger number only varying in some point of detail, such as the use of proof spirit.

The tinctures prepared by exactly this process are—

Aconiti with rectified spirit.
Buchu with proof spirit.
Calumbæ ,,
Cascarillæ ,,
Chirettæ ,,
Cinnamomi ,,
Colchici sem. ,,
Conii ,,

Cubebæ with rectified spirit.
Digitalis with proof spirit.
Gallæ ,,
Hyoscyami ,,
Jalapæ ,,
Krameriæ ,,
Lobeliæ ,,
Lupuli ,,

Myrrhæ with rectified spirit.
Sabinæ with proof spirit.
Scillæ "
Senegæ "
Sennæ "
Serpentariæ with proof spirit.
Stramonii "
Sumbul "
Valerianæ "
Zingiberis with rectified spirit.

In the following tinctures the same proportion—viz., 2½ oz. of the active constituent—is used to produce a pint of tincture but some other mode of extraction is followed:—

Assafœtida is macerated in 15 oz. of spirit, filtered, and as much spirit added to the filtrate as makes it measure a pint. Rectified spirit. Seven days.
Cocci, proof spirit. Seven days.
Limonis, proof spirit. Seven days. Sliced peel.
Lobeliæ ætherea, spirit of ether. Seven days' maceration.
Tolu, rectified spirit. Six hours, or till dissolved.
Valerianæ ammoniata, aromatic spirit of ammonia. Seven days.

This makes thirty-two tinctures, in which there are 2½ oz. of the crude drug to a pint of solvent, or an ounce of the tincture equals a drachm of the drug from which it is named.

A second list of tinctures may be drawn out, in which the proportion is 1 oz. of the drug to a pint of spirit.

Arnica root, rectified spirit.
Belladonna leaves, proof spirit.
Saffron, proof spirit. The process being maceration and percolation as used in the first part of the first list.
Indian hemp (extract), rectified spirit. Dissolve.
Castor, rectified spirit. Seven days' maceration.

state, which is equal to 1½ oz. of the powder, softening this down with warm water, and then adding rectified spirit and water to make up 1 pint of tincture of the strength of proof spirit. The medicinal value of the tincture thus prepared is no doubt the same as that obtained by the pharmacopœial process, but its colour is paler, and its odour rather stronger.

Tinctura Quinæ

Will deposit some of the quinine in cold weather unless some excess of acid be present, about 1 minim of diluted sulphuric acid to each grain of sulphate of quinine being a useful addition.

Tinctura Cardamomum Composita.

The seeds are to be freed from the pericarps and bruised before being weighed; ¼ oz. is used for making a pint of tincture, and about 3 drachms of the entire capsules yield ¼ oz. of the seed. Though cardamoms give the name to this tincture, it contains an equal quantity of caraways and double as much cinnamon.

Tinctura Chloroformi Composita

Contains 1 part of chloroform in 10, and is consequently double the strength of the spirit of chloroform, besides being one half compound tincture of cardamoms.

Tinctura Cinchoniæ Composita

Is made with pale bark, 2 oz. in a pint, and is a warm aromatic tincture, but not rich in quinine.

Tinctura Cinchoniæ Flavæ

Is made with double the quantity of bark, and being a species which yields quinine abundantly (not less than 2 per cent., according to the British Pharmacopœia standard), it is a good tonic tincture, but not aromatic. The quinine it contains should be about 1½ to 2 grains per ounce, consequently about a quarter of the *quinine* strength of the tincture prepared from the sulphate of the alkaloid; but its tonic val is much higher than this proportion would suggest, as t other tonic principles of the bark are also present.

Tinctura Ferri Acetatis.

Acetate of potash and persulphate of iron are both solubl in spirit, but on being mixed double decomposition take place, and sulphate of potash, which is insoluble in spirit, i precipitated, while acetate of peroxide of iron is retained in solution. By keeping, it acquires an odour of acetic ether; a basic acetate of iron being deposited, the tincture is paler and weaker. The addition of a small excess of acetic acid would probably be an advantage, and the tincture should be kept in the dark. The process might also be modified with advantage, by rubbing the acetate of potash with the liquor ferri before adding spirit; the precipitate thus produced is denser.

Tinctura Ferri Perchloridum

Is made by mixing 1 measure of strong solution of perchloride of iron with 3 measures of rectified spirit. A fluid ounce of the tincture contains about 62 grains of anhydrous perchloride of iron. It acquires an ethereal odour by keeping, and if prepared with an exactly neutral chloride, is

Tinctura Iodi

. iodine in a pint of rectified spirit, with ¼ oz. assium.

Tinctura Lavandulæ Composita

minims of oil of lavender in a pint; and oil of lavender," we find that the Pharma- sanctions the use of that distilled in Britain vers of *Lavandula vera*. There are many other which such restrictions are in force, and not ere the article is named. It is necessary, remember them, as in this case, when oil of rdered, the English oil distilled from flowers of *ra* only can be legitimately used. Oil of rose- is also contained in this tincture, is ordered to rom the flowering tops, but not necessarily in t also contains cinnamon bark and nutmegs, and y red sandal wood.

Tinctura Nucis Vomicæ.

pared from powdered *Nux vomica* with rectified ceration and percolation in the usual manner, n being 1 part of nux in 10 of spirit.

Tinctura Rhei

e with a much larger portion of rhubarb than y ordered, viz., 2 oz. instead of 1¼ oz. to the contains cardamoms, coriander, and saffron, and contain liquorice.

Tinctura Zingiberis Fortior

tincture made by a pure process of percolation; mes the strength of the usual tinctures, viz., pint, and is used principally for making syrup

Medicinal Wines

Very much resemble the tinctures, but are less alcoholic, t proportion of spirit in sherry being from 17 to 20 per ce of rectified spirit; the Pharmacopœia defines that it shou contain 17 to 18 per cent. of alcohol, which is equal to abo 20 to 21 per cent. of rectified spirit, and is about as strong sherry can usually be obtained. Orange wine is directed contain about 12 per cent. of alcohol, besides which the both contain small quantities of extractive matter, vegetabl acids, and salts. Bitartrate of potash being a normal constituent of grape juice, occurs in all the grape wines, thoug more abundantly in the new wines; as the fermentation goe on, the increase in the percentage of alcohol causes th precipitation of the greater bulk of the bitartrate; the smal portion that is retained is useful in aiding the solution of th iron wire employed in making the vinum ferri of the Britis Pharmacopœia; a small quantity of tannin, which it als contains, is the cause of the blackness.

The medicinal wines are—

Vin. Aloes—about 18 gr. in 1 oz.
,, Antimon.—2 gr. in 1 oz.
,, Colchici (Corm)—87 gr. in 1 oz.

samples prepared with inferior acid wines were comparatively free from change with keeping. The addition of 3 or 4 grains of tartaric acid per ounce is an advantage in preventing this deposit.

Tartaric acid itself is not exempt from decomposition when kept in solution in water, and it is not unlikely that acetic or hydrochloric acid would be more advantageous. No doubt the spirit in the wine would retard the decomposition of tartaric acid, but acetic acid is not only more stable in itself, but also has an antiseptic action upon most organic substances.

VINEGARS.

Acetic acid being one of the best solvents for alkaloids, vinegar, or the pure acid diluted, may be advantageously used for extracting various vegetables, though the number of vinegars at present official is limited to two, viz., acetum cantharidis, which is prepared with strong acetic acid; and acetum scillæ, which is prepared with an acid of the strength of vinegar, with the addition of spirit.

Ordinary malt vinegar is official, though the only preparation in which it is directed to be used is the emplastrum ceratum saponis, in which an acetate of lead is extemporized by boiling oxide of lead in vinegar. Malt vinegar of the Pharmacopœia is directed to contain 4½ to 5 per cent. of acetic acid, and is allowed to contain a small portion of sulphuric acid, which, however, must not exceed 1 part in 1,000.

LINIMENTS,

Though of very various compositions, may be classed along with tinctures for our present purposes.

Linimentum Aconiti—Linimentum Belladonnæ.

These liniments are both prepared from the coarsely-powdered root, by moistening 20 oz. of it with spirit, allowing it to macerate for three days, then packing it in the tube of a percolator, and putting 1 oz. of camphor int receiver, and slowly percolating spirit through the root the camphor till the product measures a pint; thus an o of the liniment may be considered to represent an ounc the root, though it is far from containing all the a matter which exists in that quantity of root.

To promote the best practicable exhaustion of the mat the root should be so finely divided as to pass through a s twenty holes to the linear inch, this rough powder b moistened with just so much of the spirit as suffices to d it, not making it positively wet; it is then to be packed considerable force in the percolator. This necessarily m the percolation slow, but insures its being effectual, avoids the loss of much spirit. The root, as usually f in commerce under the name of rough powdered bellado is not nearly so fine as desirable.

Linimentum Ammoniæ—Linimentum Calcis—Linimentu Hydrargyri.

These are emulsive liniments containing imperfectly sa fied grease.

The linimentum ammoniæ is olive oil partially sapon

Linimentum Camphoræ—Linimentum Camphoræ Composita.

It is necessary to note the difference in these two preparations, it being not an uncommon thing in some neighbourhoods to overlook the simple liniment altogether, excepting under the name of camphorated oil.

Camphor liniment is 1 part of camphor dissolved in 4 parts of olive oil. Compound camphor liniment is—camphor, 2½ oz.; oil of lavender, 1 drachm; strong solution of ammonia, 5 oz.; and spirit of wine, 15 oz.

Linimentum Chloroformi

Consists of equal parts by measure of chloroform and *simple* camphor liniment.

Linimentum Oleum Crotonis

Contains 1 drachm of croton oil in the ounce, the remainder being equal parts of rectified spirit and oil of cajeput.

Linimentum Iodi,

As I before noticed, in speaking of the tinctures, contains five times as much iodine as the tincture, and four times as much iodide of potassium and a little camphor.

Linimentum Potassii Iodidi cum Sapone

Is a gelatinous mass obtained by dissolving—

Hard soap	1½ oz.
Hot water	7 oz.

And adding a solution consisting of—

Iodide of potassium	1½ oz.
Glycerine	1 fl. oz.
Water	3 oz.

And subsequently flavouring it with 1 fl. dr. of oil of lemon.

Its gelatinous condition is a very questionable advantage, but being customary, it is well that all pharmacists should produce it alike.

The soap which is best adapted for the liquid liniment being least suitable for the gelatinous, common curd soap answers well. I have used that made in tablets by Anderson and Cattley with perfectly satisfactory results.

This preparation was introduced as an improvement the ointment of iodide of potassium, and where the greas of an ointment is objected to this has the advantage. 1 have been various modifications suggested as further provements, but principally having regard to its appear If a suitable curd soap be used, there is no difficulty in ma a satisfactory compound. Therapeutically, the object sought is the absorption of the iodide of potassium by skin; probably this would be better secured by incre glycerine which would keep the liniment longer semi-fluid condition.

Linimentum Saponis

Contains 2½ oz. of hard soap in a pint, and should clear pale yellow fluid.

The olive oil hard soap used in this liniment consists mixture of oleate of soda with margarate or stearate palmitate of the same base; these latter salts have but solubility in cold spirit, and the bulk of them is rejected a insoluble residue when the temperature during macera does not exceed 70° Fahr.; but if the heat be greater then larger proportion of these salts taken up than remains sol at ordinary temperatures, the result being that the lini

The solubility of castor oil in spirit is here made use of, to enable an alcoholic liniment to retain the smoothness and lubricating qualities which a fixed oil imparts.

Linimentum Terebinthinæ

Contains—

Soft soap	2 oz.
Camphor	1 oz.
Oil of turpentine	16 fl. oz.

Linimentum Terebinthinæ Aceticum

Contains—

Oil of turpentine,
Acetic acid,
Liniment of camphor, in equal measures.

The latter, it must be remembered, is the oily, not the ammoniacal liniment.

It has been proposed to substitute an equivalent proportion of glacial acetic acid, as it is soluble in oils, and the liniment, when so made, does not separate on standing. Oil of turpentine and liniment of camphor each 3 parts, glacial acetic acid 1 part, gives a more elegant and probably a more active preparation.

QUESTIONS FOR EXAMINATION.

What is meant by over proof spirit, and how is it reduced to proof?

What is meant by under proof spirit, and how can it be raised to proof?

What is the difference between the strengths of the aromatic spirits and essences of the Pharmacopœia?

What is the general process for making tinctures?

Name the most notable exceptions to the general rule of the strength of tinctures.

What is the difference between the alcoholic value of wines and tinctures?

What condition promotes the permanence of ipecacuanha wine?

RECAPITULATION.

To reduce our spirit to proof, add to 100 measures of it as much water as makes it measure 100, plus the number it was over proof.

Spirit under proof indicates spirit of such a strength as could be obtained by mixing proof spirit and water; the number under proof indicates the number of measures of water in 100 measures, the remainder being proof spirit.

The aromatic spirits contain 2 per cent. of the essential oil giving them their name, the essences contain 20 per cent. —both by measure.

The general rule for the strength of tinctures is that 1 fl. oz. contains the soluble matter from 1 drachm of the drug from which they are named. There are several important exceptions to this rule, notably tincture of opium and tincture of quinine.

Medicinal wines resemble tinctures, but are much less alcoholic, proof spirit tincture containing nearly 50 per cent. of alcohol, and the wines from 12 per cent. to 18 per cent.

Ipecacuanha wine is more permanent if free acid be

LECTURE XVI.

OFFICIAL PRODUCTS OF DISTILLATION AND SUBLIMATION.

Hydrocyanic Acid—Nitric Acid—Ether—Aromatic Waters—Chloroform—Essential Oils—Oils of Lemon, Nutmeg, Mustard, Spirit of Nitre, Spirit of Ammonia—Official Products of Sublimation—Chlorides of Mercury.

I PROPOSE to treat first of a group of pharmaceutical products obtained by distillation, containing a variety of diverse materials associated mainly by their mode of production, but also, more or less, by certain qualities in common. They are all liquids free from sediment and leaving no fixed residue, the appearance of sediment or fixed residue being evidence of faulty manipulation. The general features of the process having been described in a former lecture, I will now direct your attention more particularly to some considerations connected with the products themselves, and only point out a few particulars relating to the process where modifications or peculiarities seem to require notice.

Hydrocyanic Acid.

Hydrocyanic acid is obtained by distilling yellow prussiate of potash with sulphuric acid and water. The yellow prussiate is dissolved in a portion of the water; the acid diluted with another portion and cooled; they are then mixed and slowly distilled, the products being carried into a receiver containing a third portion of the water. The water in the receiver serves to condense any gaseous hydrocyanic acid which may not be condensed with the water which distil it may consequently be regarded as a case of distillation co bined with the solution of a gas. Fig. 16, page 98, represen an arrangement of apparatus which may be used for th purpose, substituting a sand bath for a water bath, a taking care that the tube of the condenser dips into t water contained in the bottle.

However carefully the process may be conducted, it always desirable to control the accuracy by a volumet examination of the distillate, and add the quantity of wat which may thus be found necessary to reduce the streng down to precisely 2 per cent. As it also loses strength keeping, old samples should not be used unless proved analysis to have approximately the standard strength.

Nitric Acid.

The strength and purity are the only two points to whi we need at present give our attention. The specific gravi is 1·42, which is advantageously fixed upon as being the m permanent, on account of stronger acids being reduced to t strength by boiling, and weaker acids increasing in streng by the same treatment up to the same point.

In a careful experiment, Mitscherlich obtained from every 100 parts of absolute alcohol—

65 of ether,
17 of water, and
18 of undecomposed alcohol, in the receiver.

The precise nature of the changes which take place during the conversion of alcohol into ether and water is not clearly established, and their study belongs rather to chemistry than pharmacy. I will not, therefore, enter into the question, beyond reminding you that alcohol contains the elements of ether and water, and that distillation with sulphuric acid converts the former into the two latter without itself undergoing any change, the name "sulphuric ether" being still frequently though incorrectly used. The product of distillation, I have just said, contains alcohol and water dissolved in the ether. The addition of a large bulk of water causes the precipitation of the greater part of both the alcohol and the water; the comparatively pure ether floating on the top may be decanted and further purified by a second distillation, which should be stopped when the total distillate has a specific gravity of 735 at 60° Fahr., as indicated by a specific gravity bead placed in the receiver. To make *pure ether* of the Pharmacopœia, a second washing is required to remove a portion of spirit still adhering, and another rectification from lime and chloride of calcium to remove the last traces of water.

Aromatic Waters.

The aromatic waters constitute a natural group of pharmaceutical products, the most of them being of very simple nature, and requiring little else than a few general remarks upon the class.

If we regard camphor as a concrete essential oil, we may say the waters are obtained by agitating the oil with water, by distilling the oil with water, or by distilling the material yielding the oil with water, to which we may add the non-official processes of rubbing the oil with sand or magnesia, agitating this with the water, and filtering; and, lastly, di solving the oil in spirit, and adding this to the water. Mu has been said upon the relative merits of these vario processes. We have not time to enter fully into their co sideration now; but I must remark, in passing, that t presence of spirit in the waters is quite objectionable. have repeatedly seen waters prepared by the aid of spi turn sour by keeping, the spirit, no doubt, being convert into acetic acid. The use of magnesia has been objected on account of its power of forming salts with the oils, part the magnesia itself remaining in solution, and retaining mc than the legitimate quantity of oil. As far as my experien goes, when it is necessary to extemporize a water, nothing gained by the use of magnesia or sand over simply addi the oil to the water, hot in preference, using violent agitatic and filtering through paper.

A further objection to the use of magnesia is the chance its interfering with any salt which may be prescribed alo with the aromatic water; the chance of this is the greater consequence of its solubility being increased by some at le of the essential oils.

In the Pharmacopœia camphor water is the only prepar

The waters, as a class, are simple aromatics, commonly used as vehicles for more potent remedies, imparting to them an agreeable flavour and warm carminative qualities; but there is one notable exception. Aqua laurocerasi is a powerful poison from the quantity—and the *uncertain* quantity—of hydrocyanic acid it contains. While the other waters may be taken *ad libitum*, laurel water is given in doses of 5 to 30 drops. It is a pity that an article of this kind should be rendered official without there being any rule for insuring uniformity of its strength.

Chloroform.

One part of rectified spirit and 16 parts of water are mixed in a large glass retort, and heated to 100° Fahr.; 6 parts of chlorinated lime and 3 parts of hydrate of lime are then added, and heat applied till active ebullition has commenced; the heat is then immediately withdrawn, and the distillation allowed to go on. It is necessary to have the still body much larger than the measure of the materials put into it, as considerable frothing takes place. It is also necessary to attach a condenser, supplied with sufficiently cold water, to avoid the loss of so volatile a product as chloroform, which boils at 142° Fahr. When once in the receiver, however, it is in some measure protected from loss by evaporation. Its specific gravity being 1·49, it sinks to the bottom of the water that distils over with it. In the crude state it is contaminated with spirit which has escaped decomposition, and a trace of essential oil, resulting from the reaction. It is freed from the former by washing with water; and from the latter by agitation with oil of vitriol, which decomposes the oil but does not act upon the chloroform. It is decanted from the oil of vitriol, and finally purified by agitation with slaked lime and chloride of calcium, which combine with adhering water, and fix it while the chloroform is again distilled.

It is important to use pure sulphuric acid in the latter part of the process, as a contamination of nitric acid gives the

chloroform a tendency to decompose by keeping, more e
ally if exposed to light.

Essential Oils.

The essential oils are distilled in the same manner a
aromatic waters, except that the quantity of water is d
ished; and sometimes the water is returned to the still
and again with more of the herb yielding oil. Th
accumulates in such quantity that it may be readily ski
off the surface or separated by a Florentine receiver, wh
a vessel shaped somewhat like a coffee-pot, with a short
on its rim and a long spout attached to the bottom.

The whole products of distillation flowing into the Fl
tine receiver are separated by subsidence, the water flo
off by the long spout, which is so placed as to carry awa
fluid which occupies the bottom of the receiver, at the
time that any supernatant oil is flowing away in an op
direction by the short spout.

Many of the essential oils are directed by the Pha
copœia to be distilled in Britain; not that it is impossi
distil good oils abroad, nor impossible to have inferior o
British manufacture, but that the home distilled oils are

place on the contact of water. The nutmegs contain both fixed and volatile, ready formed, consequently yield them both when subjected to pressure.

Most of the essential oils are lighter than water, but there are a few exceptions, *e.g.*, the oils of cassia, cinnamon, and cloves being heavier.

Oil of mustard is perhaps the only oil which requires a special notice at present. If the mustard seed be pressed dry it yields a sweet fixed oil, in which there is no trace of the pungency of mustard; but if the mustard be macerated in water and distilled, an oil comes over which is characterized by extreme pungency and irritating action upon the skin. The essential oil thus obtained does not exist ready formed in the seed, but is the product of a decomposition which takes place when two of the constituents come in contact with water. Myronic acid, by the action of synaptase, yields the oil of mustard.

The essential oil of bitter almonds is another instance of an oil being produced by the action of water upon principles contained in the material from which it is distilled; it, however, is not an official product.

Spiritus Etheris Nitrosi.

Nitric acid	3 fl. oz.
Sulphuric acid	2 fl. oz.
Copper wire	2 oz.
Rectified spirit	3 pints, or q.s.

The sulphuric acid being added to 1 pint of spirit, and then 2½ oz. nitric acid added, the mixture is poured upon the copper wire in a still fitted with a thermometer. Heat being applied to keep the temperature between 170° and 180° Fahr., nitrous ether distils along with some unchanged spirit. The change which takes place may be represented as follows:—

Old Notation.

$$C_4H_5O,\ HO + 2\ SO_3 + NO_5 + 2\ Cu = \\ C_4H_5O,\ NO_3 + 2\ CuOSO_3 + HO.$$

New Notation.

$$C_2H_6O + HNO_3 + H_2SO_4 + Cu = C_2H_5NO_2 + 2\ H_2O + CuSO_4$$

The nitrous ether and spirit which pass over requi thoroughly efficient condenser to reduce them to the li state, as the nitrous ether boils at 61·5° Fahr.

The remaining ½ oz. of nitric acid is added when the ac grows slack, and distillation is continued till 15 fl. are obtained. To the distillate is added as much s as will bring the density to ·845; the density of nit ether being ·947, and that of rectified spirit being ·838 will be observed that the specific gravity is no guide to medicinal value of the product, as its density may be increa by either the addition of water or of nitrous ether.

When new it is nearly free from acid, and will, on be mixed with twice its volume of saturated solution of chlo of calcium, yield 2 per cent. of nitrous ether by settli The nitrous ether being partly retained in solution, the 2 cent. does not show the whole quantity present, but quantity in excess of what is retained by the solution chloride of calcium and spirit from which it has separat The total quantity of nitrous ether present should be 10 makers it is generally found decidedly acid, and incapable of yielding the required film of nitrous ether—defects no doubt resulting from the instability of the ether. The decomposition of the nitrous ether is much more rapid when the preparation contains more than its legitimate quantity of water. It has been stated that the acidity is due to acetic acid, but the powerful action it commonly exerts upon iodide of potassium would rather indicate the liberation of some nitrous compound.

Spiritus Ammoniæ Aromaticus.

Carbonate of ammonia	8 oz.
Strong liquor of ammonia	4 fl. oz.
Essential oil of nutmeg	4 dr.
Oil of lemon	6 dr.
Rectified spirit	6 pints.
Water	3 pints.

Distil 7 pints.

When the ordinary carbonate of ammonia is added to the spirit, water, and liquor of ammonia used in preparing this article, an additional equivalent of ammonia enters into combination, forming the salt known as monocarbonate of ammonia. The change may be expressed thus—

Old Notation.

$$2\,NH_4.O,\ 3\,CO_2 + NH_4O = 3\,(NH_4O,CO_2).$$

Or, according to the new equivalents—

$$N_4H_{16}C_3O_8 + N_2H_8O = N_6H_{21}C_3O_9\ ;\ \text{or, } 3\,N_2H_8CO_3.$$

The salt thus formed being much more volatile than the ordinary carbonate of ammonia, distils along with the spirit and oils of lemon and nutmeg. Cloves were formerly used in this preparation, but they are now omitted, as they cause the spirit to become brown by keeping. The ultimate strength of the product is a little below rectified spirit, there being 7 pints distilled from the mixed ingredients containing 6 pints of rectified spirit.

Spiritus Ammoniæ Fœtidus.

Assafœtida		1½ oz.
Strong liquor of ammonia		2 oz.
Rectified spirit . . .	q.s. to make	20 oz.

Contains caustic instead of carbonate of ammonia, and is impregnated with the essential oil of assafœtida. The ammonia is added after the distillation.

THE PRODUCTS OF SUBLIMATION.

The various substances thus obtained are usually manufactured on the large scale, and are consequently rather subjects of study under chemistry and materia medica than pharmacy; the only two for which the editors of the Pharmacopœia have thought it necessary to provide formulæ are the two chlorides of mercury. The chief articles of materia medica obtained by sublimation are—acid benzoic; acid arsenious; ammonia carbonate; ammonium chloride; camphor; mercury perchloride; mercury subchloride; iodine; sulphur.

They should all be entirely volatilized by heat, and some are also volatilized slowly at ordinary atmospheric temperatures.

Subchloride of Mercury.

The same materials are used in this as in the last, with the addition of metallic mercury, which is first rubbed with the sulphate of mercury to reduce it from a persulphate to subsulphate.

$$HgSO_4 + Hg = Hg_2 . SO_4$$
$$Hg_2SO_4 + NaCl = Hg_2Cl + NaSO_4.$$

The process having been described in the lecture on sublimation, we need now only draw attention again to the fact that it undergoes partial decomposition on sublimation, a small quantity of corrosive sublimate and metallic mercury being formed.

QUESTIONS FOR EXAMINATION.

What is the characteristic quality of all products of subimation, and how would you divide them into two sublasses ?

What are the distinctive characters of products of distillaion ?

What circumstances render it important to have hydroyanic acid constantly tested ?

What are the usual doses of aromatic waters ? Give a otable exception. State some objections to the use of spirit r magnesia in extemporizing an aromatic water.

State the general mode of procuring essential oils, and ote one or two exceptional cases.

What characters should spirit of nitrous ether possess ? What defects are commonly found in commercial samples ? What is the value of testing its density ?

RECAPITULATION.

Products of sublimation should be entirely volatile, some at ordinary atmospheric temperatures, others only at higher heats.

Products of distillation should be free from sediment entirely volatile also.

Hydrocyanic acid, being very liable to variation, requ systematic testing.

The aromatic waters should contain nothing but water essential oil; if extemporized, the use of magnesia or s is objectionable; with the exception of laurel water, t have little activity.

Essential oils usually exist in the plants from which t are obtained, and are extracted by distillation; oil of lem is an exception, inasmuch as it is extracted by expressi oil of mustard is an exception in being formed by decomposition of other principles contained in the seeds

Spirit of nitrous ether should contain but little free a and should evolve a film of nitrous ether on mixing w solution of chloride of calcium; it is not difficult to mak with these qualities, but impossible to keep it so. Its dens does not indicate its strength.

LECTURE XVII.

OFFICIAL PRODUCTS OF FUSION.

Ointments—General Instructions—Mercurial Ointment—Spermaceti Ointment—Stirring—Nitrate of Mercury Ointment—Plasters—Mercury, Belladonna, Cantharides, &c.—Other Products of Fusion—Purified Bismuth—Bromide and Iodide of Potassium.

OINTMENTS, PLASTERS, ETC.

MANY of the official ointments do not involve fusion, but they are most conveniently treated along with others which it is necessary to reduce to the fluid state in the process of making.

Those which are not melted are—

Ung.	aconitiæ	8 gr.	to 1 oz.
„	antim. tart.	¼ oz.	„
„	atropiæ	8 gr.	„
„	belladonnæ	80 gr. extract	„
„	cadmii iodidi	62 gr.	„
„	creasoti	1 dr.	„
„	gallæ	80 gr.	„
„	gallæ cum opio	32 gr. opium	„
„	hydrarg.	1 part in 2.	
„	„ ammoniati	62 gr.	„
„	„ iodid. rub.	16 gr.	„
„	„ subchlor.	80 gr.	„
„	iodi	32 gr.	„
„	plumbi acet.	12 gr.	„
„	„ carb.	62 gr.	„
„	„ iodidi	62 gr.	„
„	potassæ sulphuratæ	30 gr.	„
„	potassii iodidi	64 gr.	„
„	sulphuris	120 gr.	„
„	„ iodidi	30 gr.	„
„	veratriæ	8 gr	„
	zinci	80 gr.	„

In making these, the chief point requiring attenti
have the dry, active materials finely powdered and tho
mixed. This requires special care in the case of ta
antimony, iodide of cadmium, sulphurated potash, an
of sulphur, all of which are apt to be rough and un
to use unless great attention be paid to the careful g
The iodide of sulphur ointment may be made smo
of a dark brown colour by the addition of a little i
potassium and water, which would probably be an i
ment to the official formula.

Sulphurated potash ointment is also more readil
smooth by the addition of a little water.

Unguentum Potassii Iodidi.

Iodide of potassium	64 gr
Carbonate of potash	4 gr
Water	1 dr
Lard	1 oz

In this instance the smoothness of the ointment is
by the salts being dissolved in water. The addition of
ate of potash to this ointment in the present Pharm
prevents its becoming yellow by keeping, which was a
the case with the old form, the ointment becoming ra

added, the mixing is less perfect. An excess of water probably increases the tendency to mouldiness. The addition of a little oil of cloves would tend to its preservation, but as the formula stands it is better prepared fresh when required. Probably the use of spirit or glycerine for softening the extract would diminish its tendency to mouldiness.

Unguentum Gallæ.

Powdered galls	80 gr.
Lard	1 oz.

We are not directed to use heat to soften the lard in the preparation of ointments which contain simply lard and a dry powder; but in cold weather the use of a little heat is desirable, as it very much facilitates the production of a perfect mixture. When we have recourse to artificial heat with such an object, it is best to use just so much as reduces the lard to a creamy consistence, as we thus avoid the chance of the powdered material sinking to the bottom, and save both the time which would have been occupied in rendering it fluid, and that which would have been spent in stirring it till cold again. In the case of unguentum gallæ, there is an additional reason for avoiding much heat, as the galls run into hard knots if heated too much; after which it is almost impossible to make the ointment fit for use.

Unguentum Hydrargyri.

Mercury	1 lb.
Lard	1 lb.
Suet	1 oz.

Requires long-continued rubbing at a gentle heat, just sufficient to keep the ingredients in a creamy condition. It is usually made on the large scale by machinery. As the mercury is only oxidized to a very small extent, it may be recovered in the metallic state by melting the ointment and allowing it to settle; if then washed with a little ether to remove the adhering grease, 33 parts of the ointment should yield 16 of mercury.

It is desirable that testing of purchased samples should not be entirely omitted, as the appearance is not much guide to its quality. A simpler test than the above, though not a crucial one, is the taking of its specific gravity. One hundred parts by weight of mercurial ointment consist of—

Mercury . .	48·5 (sp. gr. 13·5)	=	3·5	measures.
Grease . .	51·5 (sp. gr. about ·9)	=	57·2	„
Total . . .			60·7	

Consequently 100 oz. by weight should measure 60·7, or, striking off the fraction, say 2½ oz. by weight equals 1½ oz. by measure. In making an examination of this kind, it is most important to avoid any air-bubbles being entangled in the ointment, which would add to its bulk without increasing its weight, and thus imply a deficiency of strength.

The pale colour of a sample which recently fell under my notice led me to examine its specific gravity, which turned out to be about 1·6, or nearly what the above calculation would make it, *i.e.*, 1·65; and the paleness of its colour proved to be the result of a less perfect division of the mercury.

The official instruction had been obeyed, literally obeyed, for metallic globules were not visible to the naked eye; but

Unguentum Cetacei—Unguentum Simplex.

These may be taken as typical examples; in the former some latitude is allowed as regards the quantity of oil to be used, so that the ointment may be firmer or softer according to the desire of the consumer, or the requirements of the season. The condition of the ointment is also influenced by the stirring. The Pharmacopœia says, stir constantly while it cools. But it is not sufficient to stir it till of a creamy consistence; the solid ingredients are more or less crystallizable, and as the cooling continues they deposit partly in an indistinctly crystallized form, which gives a hardness or rigidity to the ointment which is very objectionable; and it is difficult afterwards to make it smooth by rubbing; but if the stirring be continued constantly till the ointment is so cold that no more crystallization will take place, the crystals which are formed are very small and not agglomerated, so that the ointment is soft and plastic instead of being rigid. An ointment which contains so small a proportion of oil that it is firm while in this plastic state, is less affected by changes of temperature than an ointment which has the same degree of firmness with more oil, and having been left at rest during the latter part of the cooling.

A sample of spermaceti ointment containing—

Spermaceti	5 oz.
White wax	3 oz.
Almond oil	1 lb.

melted and stirred till it was in a semi-fluid, semi-solid state at 93° Fahr., a portion taken out and cooled at rest was hard at 63°; but another portion, having been stirred till it fell to 73°, was plastic at 63°. It would bear the ordinary changes of season without becoming either too hard or too soft for convenience, but if the quantity of oil had been so much increased that the ointment was of a conveniently soft consistence in cold weather with the small degree of stirring, viz., only till the ointment was in a creamy, semi-solid condition, then any rise in the temperature would make it unmanageably soft. Different samples of oil appear to to require different proportions of the hard materials to them a suitable consistence.

Though the consistence of spermaceti ointment is left definite, it is intended to be softer than the simple ointm which contains—

Lard	3 oz.
White wax	2 oz.
Oil of almonds	3 oz.

Unguentum Cantharidis.

Cantharides	1 oz.
Yellow wax	1 oz.
Olive oil	6 oz.

This is prepared by infusing cantharides in oil, filte and adding melted wax to give the required consiste The ointment is of a light-yellow colour, and should be from particles of the fly.

Unguentum Elemi—Unguentum Resinæ.

These two ointments require filtering while in the state, as some clotty matter separates on the mixture of resin with the grease; this is the case even if the resin the grease are both quite clear before mixture.

ut in a case like this a little of the olive oil, which forms ne of the ingredients of the ointment, may be used. The ddition of camphor makes the ointment much softer than it ould be without it—a circumstance which is easily under- ood if we keep in mind that the camphor is a concrete sential oil which becomes fluid by union with the grease.

Unguentum Hydrargyri Nitratis.

Mercury	4 oz. (by weight)
Nitric acid	12 oz. (by measure)
Lard	15 oz.
Olive oil	32 fl. oz.

There has been much said about the difficulty of making good nitrate of mercury ointment, and a great number of rmulæ have been suggested. There need not, however, be ny deviation either from the ingredients or the modes of perating directed in the British Pharmacopœia. It is sential that the solution of nitrate of mercury be mixed ith the grease while they are so warm as to cause a brisk fervescence. If the heat be too great, there is fear of loss om the ointment boiling over the top of the pan, and if the at be insufficient, more is to be applied till free efferves- nce takes place. If long kept, the ointment becomes dark loured, the evaporation of nitric acid being one change, but rhaps not the only change which it has thus undergone. is better, therefore, to make only so much at a time as ill be consumed before change of colour takes place. It is cessary to avoid bringing this ointment into contact with etallic substances, which might decompose the nitrate of ercury it contains; consequently the Pharmacopœia directs to be made in a porcelain vessel. After the ointment is mpleted it is not very rapidly decomposed by either copper r iron.

In the British Pharmacopœia formula there are 15 oz. of rd to 32 of olive oil, which makes the ointment rather soft, ut if these quantities be reversed—that is, 32 of lard to 15 f oil—a more convenient consistence is produced.

Unguentum Plumbi Subacetatis Compositum.

Solution of subacetate of lead . . .	6 fl. oz.
Camphor	60 gr.
White wax	8 oz.
Oil of almonds	1 pint.

The wax is to be melted with four-fifths of the oil, and camphor to be dissolved in the remaining fifth, that it n be kept separate to avoid the loss of camphor which wo take place if the whole were heated together. When wax and oil cool so much as to become milky, the solutio acetate of lead is stirred in, forming a mixture analogous an emulsion.

The subacetate of lead readily emulsifies with oil, hav much less tendency to subside than most aqueous solution

Unguentum Sabinæ.

Fresh savin tops are bruised and digested in the mel grease for twenty minutes, by which they impart to it so resin and essential oil, upon which the value of the ointm depends, and some chlorophyll, which gives it its usual gr colour. As this colour is rather fugaceous, the brightn may be considered an indication of the ointment being fre

e mercury is triturated till globules are no longer
n the ammoniacum previously melted is added,
le mixed.

remarkable that 3 oz. of mercury can be "killed"
n with so small a quantity as a fluid drachm of
ains of sulphur.

rkable power of a small quantity of sulphur to
rge quantity of mercury is well known to those
gold from quartz by amalgamation, the presence
ulphur causing a great loss of mercury, from the
e globules becoming tarnished, so that they lose
of agglomerating. The same action takes place
cess, the bulk of the mercury remaining in the
e, only a very small portion being converted into
the form of tarnish on the surface of the globules,
tates their division and prevents them from re-

Emplastrum Belladonnæ.

a plaster was formerly made by mixing the
tery extract with resin or soap plasters, but by
n imperfect compound was formed which was
adhesiveness.

esent mode of preparing belladonna plaster the
ueous extract is rubbed with about twice its
irit, which dissolves the resinous and active part
the mucilaginous matters, which are worthless,
combine well with the resin plaster; by this
resulting compound is more adhesive and more
this plaster is readily injured by heat, it is
a water bath, and requires care in spreading, to
n as gently heated as it is practicable to operate

en stated that a plaster of still better quality is
n alcoholic extract of belladonna root.

Emplastrum Calefaciens.

Four ounces of powdered cantharides are macerated in boiling water for six hours, the liquor pressed off and evaporated to one-third, and added to—

Expressed oil of nutmegs	Each 4 oz.
Yellow wax	
Resin	
Soap plaster	3½ lb.
Resin plaster	2 lb.

From the absence of the powder of cantharides, and the presence of some water, the colour of this plaster is creamy yellow.

It is customary to pour the melted plaster into water, and before it hardens to pull the mass out, double it and pull it again, by which treatment it acquires a silky appearance, a brighter colour, and greater opacity than it would have if simply cast into moulds. After this pulling process it is weighed into half-pound pieces and rolled upon a wet stone slab, to form rolls of 8 or 10 inches in length.

Emplastrum Cantharidis.

Cantharides	12 oz.
Yellow wax	7½ oz.

Emplastrum Opii.

Powdered opium	1 oz.
Resin plaster	9 oz.

The present opium plaster contains 1 part of powdered opium and 9 of resin plaster. Its predecessor in the London Pharmacopœia contained extract of opium softened with water, added to the melted plaster, and evaporated to a suitable consistence. Probably an alcoholic extract of opium would make a better plaster than either.

Emplastrum Plumbi.

Oxide of lead	4 lb.
Olive oil	1 gallon.
Water	q.s.

This plaster is a salt in which the oxide of lead is the base, and the oil supplies the fatty acids. The oil being a combination of glycerine with oleic and other acids, undergoes decomposition by boiling in contact with oxide of lead and water. The glycerine separates and is removed along with the water which has not evaporated during the process; the heat of a steam bath is recommended, as a higher heat long continued causes further decomposition of the oil, and even reduction of the lead to the metallic state.

Emplastrum Resinæ —Emplastrum Saponis.

Both these contain lead plaster, resin, and soap, the one or the other addition preponderating as the name indicates. They are more plastic and more adhesive than the lead plaster.

OTHER PRODUCTS OF FUSION.

There are various other processes of fusion in the Pharmacopœia. In the preparation of some salts, and the purification of sulphuret of antimony and metallic bismuth, the latter is perhaps the most interesting of the group, and has been the subject of much criticism. Commercial bismuth is usually contaminated with various metals, which are more or less readily oxidized by the contact of fused nitrate of potash, by which arsenic, its most frequent and most important

impurity, is removed. If any considerable percentage
copper is present it is but imperfectly separated by this trea
ment, but its presence is guarded against by the testing wi
ammonia which is enjoined.

The process answers satisfactorily in the absence of coppe
and any samples of commercial bismuth which have a co
siderable contamination of this metal should not be used f
this purpose; they may, however, be purified by being di
solved in nitric acid, and precipitated by dilution with wat
as in the official process for bismuthi subnitras; the copp
remains in solution, and by collecting, drying, and ignitin
the precipitate with charcoal it is again reduced to th
metallic state; any foreign metals, if present, being left i
the nitric acid solution, the reduced bismuth is now pur
excepting as regards arsenic. If both arsenic and copp
are present in the original sample, it is desirable to use bot
processes of purification.

The processes for bromide and iodide of potassium involv
the fusion with charcoal to reduce any oxysalt which migh
otherwise escape decomposition if heat alone were used.

The decompositions may be briefly shown thus:—

Six equivalents each of iodine and caustic potash unite into a state of quiet fusion. The salt is then poured out, and when cold dissolved in water and filtered to remove excess of charcoal, and the clear solution evaporated and crystallized.

Questions for Examination.

When solid substances are to be mixed with grease for the production of ointment, what modes of insuring smoothness may be adopted?

Describe two methods of testing the strength of mercurial ointment, and state their relative merits.

In making spermaceti ointment, how long should the stirring be continued?

Why is cantharides plaster made nearly destitute of adhesiveness?

What common impurity of metallic bismuth is not satisfactorily removed by fusion with nitrate of potash, and by what method may the bismuth be freed from it?

Recapitulation.

In making ointments the active matter should be smooth and uniformly mixed. The smoothness is usually insured by careful grinding, at other times by solution.

The strength of mercurial ointment should be tested; most advantageously by separating and weighing the mercury, or more readily, though less accurately, by taking its specific gravity.

The stirring of spermaceti ointment should be continued till its temperature falls to about 70° Fahr. to insure a plastic and smooth condition.

Cantharides plaster should possess little adhesiveness, lest, in removing it after use, it tear the skin off the blistered surface.

Fusion of bismuth with nitrate of potash is recommended to purify it from arsenic. Copper is more effectually removed by solution in nitric acid, precipitation with water, and fusion with charcoal.

LECTURE XVIII.

OFFICIAL SALINE PREPARATIONS, ETC., CRYSTALLIZED, PRECIPITATED, SCALED, OR GRANULATED.

Crystallized Salts having Volatile Acid or Base—Precipitates, Oxide of Antimony, Subnitrate of Bismuth—Chloride of Calcium, &c.—Separation of Iron—White Precipitate—Carbonate of Magnesia—Granulated Sulphate of Iron—Carbonate and Citrate of Potash—Citro-Tartrate of Soda—Scaled Salts, Sulphate of Beberine, Citrate of Iron and Ammonia, &c.

THIS is a considerable group of substances, including, besides salts, some metallic oxides, sulphides, &c. It will only be possible to take a very brief view of them, but this is of less consequence, as they are also treated by the lecturers on chemistry and materia medica, and the processes of crystallization and precipitation in the abstract have already been

The loss of acid in this way is exemplified in the case of plumbi acetas, in which we are directed to add a little acetic acid at the end of the evaporation to compensate for that lost in the process, and thus insure the absence of subacetate in the crystals.

The common instructions of the British Pharmacopœia to drain and dry the crystals on filtering paper are of course only suitable for experimental operations. The centrifugal drainer which I mentioned in a former lecture may, with the greatest advantage, be used on the manufacturing scale.

Antimonii Oxidum.

When solution of chloride of antimony is diluted with a rge quantity of water, a precipitate is thrown down, consistng of chloride and oxide of antimony united, the solution om which it has been thrown down still retaining a small uantity of antimony and a considerable quantity of hydroloric acid, produced by the mutual decomposition of chlode of antimony and water—

$$SbCl_3 + 3\ HO = SbO_3 + 3\ HCl.$$

The precise composition of the precipitate depends upon he quantity of water used, the composition varying from equivalent of chloride with 2 of oxide to 1 of chloride with 3 of oxide. The quantity of chloride present diminishes as he washing of the precipitate continues. The liquor of the hloride of antimony contains various impurities, chloride of ron most abundantly, and smaller quantities of copper, lead, nd arsenic. These are washed away along with the hydrohloric acid; when they are sufficiently removed, the remainng undecomposed chloride of antimony contained in the recipitate is decomposed by the addition of carbonate of soda, arbonic acid being liberated, chloride of sodium and oxide of ntimony formed. The precipitate is subjected to a second washing to remove the soda salts.

Bismuthi Subnitras.

The process for the preparation of this salt is very simil
to that which I have just described in connection with oxi
of antimony. The metallic bismuth is first dissolved i
nitric acid to form an acid nitrate $BiO_3\ 3\,NO_5$, which, o
dilution with a large quantity of water, throws down th
subnitrate $BiO_3\ NO_5$, leaving in solution a strongly aci
nitrate $BiO_3\ 9\,NO_5$, together with nitrates of copper, iron, (
lead, if these metals were present in the bismuth; but arseni
which is a frequent impurity of bismuth, is thrown down i
combination with the subnitrate. It is, therefore, mor
especially important to have the bismuth freed from arseni
before it is used for this purpose.

It is said that by long-continued washing the whole of th
nitric acid may be washed out of this precipitate, leavin
only the oxide; the Pharmacopœia, however, fixes the exten
of washing which has to be used, and gives as the com
position of the product, the formula $BiO_3\ NO_5\ 2\,HO$, o
$BiNO_4\ H_2O$.

It is to be dried at a temperature not exceeding 150° Fahr
(= 65·5° C.) to avoid the expulsion of the water of hydration
which it contains.

Argenti Oxidum

itated from the nitrate by means of lime water, which red to the alkaline solutions, as it is less likely to be nated with carbonate, and thus avoids the chance of e of silver being thrown down along with the oxide. e absence of carbonate, freshly-prepared lime water be used. Commercial oxide of silver often contains rbonate.

Calcii Chloridum

ned by neutralizing hydrochloric acid with carbonate Most of the native carbonates of lime contain oxide nate of iron; and with the view of separating the proto- of iron thus introduced a little chlorinated lime l to the solution, by the action of which it becomes d into perchloride, and is subsequently precipitated as by the addition of slaked lime. Proto-salts of iron imperfectly precipitated in this way, but per-salts are ely separated, hence the use of the chlorinated lime. ie mode of separating iron is adopted in the prepara- zinc, using chlorine water and carbonate of zinc in chlorinated lime and slaked lime.

the solutions thus purified the carbonates of lime c may be precipitated by the addition of alkaline tes.

recipitating carbonate of zinc, effervescence takes om the precipitated carbonate of zinc containing only lent of carbonic acid to 3 of oxide of zinc—

$$3\ ZnO, SO_3 + 3\ NaO, CO_2 + Aq =$$
$$(ZnO, CO_2 + 2\ ZnO, 3\ HO) + 3\ NaO, SO_3 + 2\ CO_2.$$

Peroxidum Humidum—Ferri Peroxidum Hydratum.

humid or moist peroxide precipitated from persul- f iron by caustic soda, and after being washed and is preserved without drying; but it should not be ed long, as the only advantage it possesses over the hydrated oxide is its greater solubility, and this it in a gre measure loses when kept for a length of time, even if pr served moist.

The hydrated oxide is prepared by drying this precipita below 212°, by which it retains 1 equivalent of water and considerable degree of solubility.

By a higher heat it loses the water of hydration, and wit it its ready solubility.

Ferri Oxidum Magneticum.

When peroxide and protoxide of iron are precipitat together they unite, forming the black magnetic oxid thus—

$$Fe_2O_3 + FeO = Fe_3O_4.$$

The official process yields a precipitate containing an exce of peroxide of iron and some water of hydration. It is no probable there is any advantage in its use in medicine as it i decomposed into proto- and per-compounds by union wit acids.

Hydrargyrum Ammoniatum.

There is no peculiarity in the process for this compound

Magnesiæ Carbonas—Magnesiæ Carbonas Levis.

It must be noted that when carbonate of magnesia is ordered, the heavy is to be used unless the light is specially indicated. They are of the same composition, viz., 3 equivalents of neutral carbonate with 1 equivalent of hydrate and 4 of water, or—

$$3\,(MgOCO_2) + MgO + 5\,HO.$$

The physical condition depends upon the degree of concentration of the solutions from which the precipitate is thrown down, and some other minutiæ which are known only to the manufacturers.

The precise processes of the British Pharmacopœia are probably rarely followed, but as the result is obtained satisfactorily by other methods this is of no moment.

Ferri Sulphatis Granulata.

This is a precipitate formed by adding a strong aqueous solution of sulphate of iron to spirit of wine. The salt is precipitated as minute crystals of precisely the same composition as the salt crystallized in the usual way.

It has been said to be a refinement without an advantage; but granulation as directed in the Pharmacopœia is a convenient mode of obtaining the protosulphate of iron free from the persulphate. The former salt being insoluble in spirit is precipitated, while the latter, from its free solubility in spirit, remains in solution; the degree of purity thus obtained is greater than the salt crystallized in the usual way, unless the process was conducted with more than ordinary care, and the granulated salt is found to be less prone to oxidation by exposure to the air.

Some manufacturers produce sulphate of iron in large crystals with this same property—a tendency to effloresce without oxidizing, but by what means they obtain these results I am not informed.

Potassæ Carbonas—Potassæ Citras.

These two salts are granulated by evaporating the solutions to dryness with constant stirring, by which operation an indistinct crystallization takes place; but as there is no mother liquor separated, the salt is not purified by the process, and to obtain satisfactory products the chemicals operated with must be sufficiently pure before granulation is commenced. In speaking of the phenomena of solution, I pointed out that a saturated solution of carbonate of potash does not dissolve any appreciable quantity of sulphate. We consequently have the means of purifying the carbonate of potash, known in commerce as "pearl ash," by simply dissolving out the carbonate in the smallest possible quantity of water, by which the sulphate is left behind, and the solution obtained is sufficiently pure to be granulated for medicinal use. The ordinary process of crystallization is not used for these salts, as they are deliquescent, and the draining and drying of the crystals would be troublesome.

Sodæ Citro-Tartras effervescens.

The granulation of this salt, or rather mixture of salts and acids, is effected by using just so much heat as causes mpound. The salts of peroxide of iron, with organic acids d the sulphate of beberine, are the principal medicinal bstances kept in scales, but it has also been suggested to ve extract of rhubarb and some other substances prepared this form.

Ferri et Ammoniæ Citras.

Peroxide of iron, freshly precipitated and washed, but not ied, dissolves pretty freely in solution of citric acid, but if e salt thus obtained is reduced to dryness, it is not again eely soluble in water. If, however, ammonia be added to e solution of oxide in citric acid, before it is evaporated, rather indefinite compound of the two citrates is formed, hich may be reduced to dryness without losing its solubility. uch is the nature of the well-known salt of the Pharmacopœia. f the oxide of iron be not in excess of the quantity prescribed, will not be precipitated by either acids or carbonates of lkalies; but if it be much in excess of the quantity ordered, hich may happen without changing the appearances, the ddition of an acid will cause the separation of the iron, as a asic citrate, while the ammonia forms a salt with the acid dded. The Pharmacopœia directs that the salt shall not ave less than 27 per cent. of peroxide of iron when calcined, nd that the oxide thus obtained shall not be contaminated ith alkali, which would result from potash or soda having een used instead of ammonia in the formation of the salt. It lso directs that the citrate, when heated with excess of caustic otash, evolves ammonia and deposits iron, and the clear alka- ne liquor from which the iron has been separated will not eposit cream of tartar if supersaturated with acetic acid, owing that tartaric acid has not been substituted for citric cid in its manufacture.

Ferrum Tartaratum

s obtained by digesting fresh, moist peroxide of iron with ream of tartar, at a temperature not exceeding 140° Fahr., ill no more peroxide of iron is dissolved.

The general characters of the salt thus obtained are similar to those of the citrate of iron and ammonia, but of course no ammonia is evolved when it is boiled with caustic soda; and if the alkaline liquor thus obtained be filtered from the peroxide of iron, and supersaturated with acetic acid, the cream of tartar originally used in the preparation of the salt is reprecipitated.

Ferri et Quinæ Citras.

In the preparation of this salt the peroxide of iron is dissolved in citric acid, the same as for making citrate of iron and ammonia; but before adding the ammonia some freshly-precipitated quinine—not the sulphate—is added, which forms citrate of quinine and dissolves; but this would not be a permanently soluble salt without ammonia; consequently ammonia is added in small successive portions, each addition causing the precipitation of some quinine, which, however, speedily redissolves, unless too much ammonia has been added.

In the tests for this salt you will find the statement that it is precipitated white by liquor of ammonia, and brown by caustic soda; the latter, however, causes the separation of both

QUESTIONS FOR EXAMINATION.

What precaution is requisite in preparing solution of acetate lead for crystallizing, and what other salts require similar re?

If impure metallic bismuth be used for preparing the bnitrate, how are the different impurities affected by the rocess?

How is iron to be separated from chloride of calcium or hloride of zinc if present as an impurity?

How is granulated sulphate of iron prepared, and what are ts advantages?

What class of substances is it customary to have scaled, nd what are the advantages of the process?

RECAPITULATION.

Some salts having a volatile acid or base are liable to lose a portion of the volatile constituent during evaporation, and should be rendered neutral again before being crystallized.

Impure metallic bismuth dissolved in nitric acid and poured into water is precipitated; most impurities which might be present remain in solution; arsenic would go down with the bismuth.

Ferrous chloride is not readily separated from chlorides of calcium or zinc until converted into ferric chloride.

Granulated sulphate of iron is more easily obtained free from persulphate than the same salt crystallized in the ordinary way, and is less liable to become oxidized by keeping.

Scaling imparts a convenient form to colloid salts, but does not insure their purity; it is therefore necessary to test their purity, especially in the case of citrate of iron and quinine, which is often deficient in quinine.

LECTURE XIX.

COMPLEX PROCESSES.

Some of the more Complex Processes of the Pharmacopœia—Tartaric Acid—Tannic Acid—Sulphate of Quinine—Hydrochlorate of Morphia—Resins of Jalap, Scammony, and Podophyllum.

THE subjects which we have to consider at present belong more especially to the manufacturer; they are too complicated to be advantageously conducted upon the small scale, but they are nevertheless processes of high-class pharmacy, and though it is not expected of any retail pharmacist that he will conduct them for himself, no one can claim a good position for his profession who is not familiar with the principles upon which they are founded, and has some idea of the details and mode of operating.

hloride, is next to be decomposed with sulphuric acid, added n sufficient quantity to decompose the tartrate of lime, and he mixture boiled for half an hour, or till it is judged that he reaction is complete. The deposit then consists of sulhate of lime, which is only sparingly soluble, and the olution contains the tartaric acid, with a small quantity also f sulphate of lime. As the solution is evaporated the lime alt is deposited, and separated by filtration before the liquor finally reduced to the crystallizing point. A further vaporation, till a pellicle forms upon the surface, prepares it r crystallization. This crop of crystals usually contains ill a small quantity of sulphate of lime, and is purified from is by again dissolving in water, filtering, and recrystalzing. The mother liquors may be made to yield a second rop of inferior acid by further evaporation and crystalzation. The mother liquors are usually dark-coloured, and re sometimes bleached by the addition of nitric acid during e evaporation, by which the colouring matters are oxidized CO_2 and NO_2 being evolved); but this endangers the conmination of the tartaric acid with oxalic.

The Pharmacopœia tests are intended to guard against the resence of oxalic acid, which would give a precipitate with lphate of lime; and against sulphate of lime, which would ive a precipitate with oxalate of ammonia; for though we eed not fear the presence of *both* in one sample, we must uard against both separately.

The process for citric acid is very similar both in the eneral principles and the precautions required.

Acidum Tannicum.

Nutgalls contain 25 to 50 per cent. of tannic acid, which freely soluble in water, spirit, or ether; but as the acid is ery prone to decomposition, either by exposure to air or eat when dissolved in water, it is not practicable to extract commercially by means of water. Ether is the solvent lways used, and generally in combination with a small quantity of water. The process is one of simple extractio and evaporation, without any means of purification, th amount of impurity extracted by the ether being so small to be of no importance medicinally. A little colour an resinous matter are the only usual contaminations; the latt renders its solution in water turbid, but is of too sma amount to interfere with the medicinal value of the produc As the aqueous solution undergoes spontaneous decompos tion, tannic acid is kept dissolved in glycerine for medicin use, or dissolved in spirit as a reagent.

Quinæ Sulphas.

The British Pharmacopœia process for sulphate of quinin consists in macerating the *yellow* bark in dilute hydrochlori acid, by which the alkaloids are rendered soluble and ar washed out by the subsequent process of percolation. Th acid liquor being next precipitated with caustic soda added i excess, the precipitate which is deposited contains the alka loids, together with a portion of the astringent acids of th bark (cincho-tannic, red cinchonic, kinic, and kinovic), which however, are held more by mechanical attachment tha chemical union, and are subsequently washed away by per

point till a film forms on the surface; it is then allowed
ool, when a considerable deposit of sulphate of quinine
s place. The sulphate of quinine is soluble in thirty
s its weight of boiling water, but requires 750 times
reight of cold. There should, therefore, be 96 per cent. of
sulphate of quinine deposited, and only about 4 per cent.
ined in the mother liquor, along with the sulphates of the
r alkaloids should they be present; sulphate of quinidine
g about three times as soluble, and sulphate of cinchonine
it ten times as soluble, as sulphate of quinine. Sulphate
morphous quinine is also present in the mother liquor.
precise nature of this amorphous quinine is a disputed
t; and so is the question of its original existence in the
, or its production from the decomposition of some of the
loids during the process of extraction.

he proportion of sulphate of quinine yielded by different
ls of bark varies exceedingly, and even in different
ples of the same species, *i.e.*, *C. Calasaya*, the product
aid by Wittstein to vary from 1 to 3 per cent. The
rmacopœia requires that yellow bark should contain not
than 2 per cent. of pure quinine; but a manufacturer
ld be quite at liberty to use any inferior quality of bark
n which he might find it profitable to extract quinine
rided the sulphate was ultimately obtained of the requisite
ity.

he subjoined table shows the proportion of quinine and
honine yielded by several kinds of cinchona :—

Quinine and Cinchonine in 100 *parts of*

Brown and Grey Barks :[*]

	Quin.	Cinch.
Hunanoco	0·40	1·70
Loxa	0·35	0·34
Pseudo Loxa . . .	0·35	0·66
Huamalies	0·30	0·80
Jaen Pallida . . .	0·56	0·60

[*] Watts's "Dictionary of Chemistry."

	Quin.	Cinch.
Yellow or Orange:		
Calasaya—		
(*a*) Plana	2·20	0·28
(*b*) Convoluta	1·10	0·42
Fibrosa	1·05	0·83
Dura	0·54	0·48
Pitaya	1·68	0·90
Red:		
Cinchona rubra	0·91	1·05

Many recent analyses of cinchonas show that much larger percentages of quinine are not uncommon. For example, in the *Pharmaceutical Journal*, October 22, 1881, Mr. McIvor's analysis gave 12·9 total alkaloidal salts; thus—

Sulphate of quinine	6·94
„ cinchonidine	4·48
„ cinchonine	0·20
„ quinidine	0·14
Amorphous alkaloid	1·14

Morphiæ Hydrochloras.

Several different processes have been devised for the extraction of morphia from opium, and separating it from the other alkaloids; it would not be profitable to occupy time with a full description of more than one, we will therehlorates of morphia and codeia are deposited as a crystalline recipitate; the whole is concentrated so far that on cooling t becomes almost solid from the bulk of crystals which eposit; the crystalline mass is folded in a cloth and strongly ressed to remove the mother liquor, which contains much olouring matter and hydrochlorates of codeia, &c., together, f course, with a portion of the morphia salt.

The cake of crystals contains meconate of lime and hydro-lorate of morphia and codeia; it is triturated with boiling ater to dissolve the morphia (and codeia); the meconate of me being insoluble, is separated by filtration. The liquor, ogether with the water which has been used for washing the econate of lime, is then evaporated again till it solidifies on oling, and the pressure in folds of calico repeated to remove further portion of impurities. If the morphia salt is still ighly coloured, crystallization is to be repeated again in the ame manner. When sufficiently free from colour, the pressed ke is dissolved in 6 oz. of boiling water, and digested with quarter of an ounce of pure animal charcoal for twenty nutes, by which the remaining colour is removed. The pure rphia is then precipitated by the addition of ammonia, the ia remaining in solution. If the ammonia is added while liquor is hot, the morphia is deposited in crystals as it and is more readily washed clean; when the washings ger give indications of chlorides with nitrate of silver, orphia may be transferred to a dish or flask with 2 oz. er, and, when it is brought to the boiling point, dilute hloric acid added by slow degrees, so that the morphia dissolved with the smallest possible quantity of acid eutral salt may result. As this solution now contains drochlorate of morphia, it may either be evaporated to or concentrated and crystallized.

llowing analysis of opium will give a general idea of rtion of various constituents besides morphia, and v necessary it must be to have a well-devised scheme a pure alkaloid from so complex a drug:—

Mulder's Analysis of Smyrna Opium.

	Good.	Inferior.
Morphia	10·84	6·30
Narcotin	6·80	7·31
Codeia	0·67	0·72
Narceine	6·62	9·00
Meconin	0·80	0·58
Meconic acid	5·12	6·12
Fat	2·16	
Caoutchouc	6·12	
Resin	3·58	
Gummy extractive	25·20	
Gum	1·04	
Mucus	19·08	
Water	9·84	
Loss	2·14	

RESINS.

The pharmaceutical resins which do not belong purely to the department of materia medica are resins of jalap, podophyllum, and scammony.

The Resin of Jalap,

Or, as it is popularly called, jalapine, differs from the jalap resin of the old Edinburgh Pharmacopœia in being more free from impurities. The process now includes washing with water, which removes small quantities of matter soluble both ıg matter is not thus completely removed; and if it is to obtain a pale-coloured resin, the powdered jalap mixed with animal charcoal in the percolator, or the macerated with the charcoal, as a second stage in the

Resin of Scammony

ned in precisely the same way from scammony root the inferior qualities of commercial scammony, by neans they are freed from any earthy or amylaceous ies they may contain.

ommercial resin of scammony, prepared from the root, ly contaminated with a portion of deliquescent matter, from imperfect washing of the resin. It is detected rating the sample in ether, which dissolves the resin, es the watery extractive. If this impurity is present notable quantity, it imparts a stickiness to the resin ure samples do not possess. If there be but a small of the aqueous extractive present, it is only detected ısolubility in ether. Recent investigations show that ıs of scammony and jalap are practically identical.

Resin of Podophyllum,

ıly known as podophyllin, is obtained by a similar but the distillation of greater part of the spirit is without the previous addition of water.

concentrated tincture, as it comes from the boiler of be added to water, the resin is precipitated, leaving in solution; but as hydrochlorate of berberin is in water, the Pharmacopœia directs that the water the precipitation of the resin should be mixed with nty-fourth of its bulk of hydrochloric acid, that the lorate of berberin may be precipitated along with the It is said that much of the activity of podophyllin upon the presence of berberin; it is, therefore, ıt to insure the presence of this active principle by tion of the acid to the water.

It is also important to examine imported samples, as m of them come from America, where, according to Profes Parish's statement in 1864, the practice of manufactur was not uniform in this respect, the U.S. Pharmacopœia directing the use of acid, and the test of purity indicati the absence of the berberin, thus—"It is partially soluble ether, and the residue, when dissolved in solution of potas is not precipitable by hydrochloric acid."

The British Pharmacopœia tests require that it should soluble in rectified spirit and in aqueous solution of ammon that it should be precipitable from the alcoholic solution water, and from the alkaline solution by acids; these r actions take place both with the resin and the hydrochlora of berberin.

If the podophyllin be boiled in dilute acetic acid, the resi remains undissolved while the berberin is taken up, and, the liquor cools, it is re-deposited in the form of a yello precipitate.

Contrary to Parish's requirements, our podophyllin, whe exhausted with ether, leaves a residue soluble in solution potassa, and which *does* yield a precipitate on being ne tralized with hydrochloric acid.

RECAPITULATION.

Tartaric acid is prepared by converting cream of tartar into tartrate of lime, and then decomposing the tartrate of lime with sulphuric acid. The tartaric acid is liable to be contaminated with sulphate of lime, or, if nitric acid has been used to oxidize the colour, it may be contaminated with oxalic acid.

Tannic acid is obtained by extracting galls with ether and a little water; the principal impurities are colouring matter and a little resin.

Sulphate of quinine is obtained from yellow bark by extraction with water and HCl, precipitating with NaO, and dissolving the washed precipitate in hot water with the least possible quantity of sulphuric acid.

Hydrochlorate of morphia is obtained by decomposing infusion of opium with CaCl, evaporating the liquor to small bulk, pressing the resulting crystals, repeating the crystallization and pressing, dissolving the crystals, precipitating with ammonia, and dissolving the washed precipitate in water and HCl.

Resin of jalap is precipitated from a tincture of the root, the spirit being distilled off, and the residue washed with water.

Resin of scammony is produced the same way.

Resin of podophyllum is precipitated from the tincture by the addition of water and HCl; the latter precipitating the berberin, which would be washed away if this addition were not made.

LECTURE XX.

DISPENSING.

Importance of Orderly Habits—Preparations in Anticipation of Requirements—Prescriptions difficult to read—Weighing—Measuring—Ambiguous Prescriptions, Unusual Doses, &c.—Modes of Mixing—Soluble Salts—Precipitation of Active Matter—Use of Distilled Water—Modes of Mixing Powders in Suspension—Filtration—Spirit of Nitrous Ether to be Neutralized—Emulsions, Egg Liniments, &c.

Practical dispensing requires for its satisfactory and successful prosecution a considerable versatility of talent. The dispenser ought to have a good fund of general information —information, it may be, which is only rarely called into requisition, yet may be essential to success on some particular occasion. Every day may call into play some knowledge which will not be wanted again for months; there are conhere is no department of business in which the formation good habits is so important as in dispensing. To do a ing by habit requires no attention, and gives no trouble ter the habit is once formed. If you have the habit of itting your measures, mortars, knives, &c., away dirty, or aving them about because they are not clean, there will be ery probability that they will give twice as much trouble to ean when wanted, and will also risk the spoiling of some edicine by being used without cleaning. If you form the bit of putting things down just where you have used them, just where it is most convenient at the time, it will obably cost you ten times as much trouble to find them xt time they are wanted; whereas, once form the habit of tting them in their right places, and doing so no longer sts either thought or trouble. You perhaps think that I n only telling you what every one knows. Be it so; I ay add, I am only telling you what very few put in actice. It is easier to find a classical scholar, an accomished chemist, or a learned botanist, than it is to find a an who both knows and practises those moral qualifications which I have been alluding; and, while this is the case, I el that I cannot omit the inculcation of those habits which ld so much to the value of a dispenser, and which, as far as y own experience goes, are so rarely to be met with.

The most common-place man can have his house in order hen he expects any one coming to inspect it, or will erform his work well on any great occasion; but the rare nd valuable qualification is the habit of doing the same on nall occasions, and on *all* occasions. Let it be your habit —a habit so strongly formed as to be your second nature— be orderly, accurate, neat, and quick, attentive to little hings, observant of everything. There is commonly more ime wasted in going through the work in a spiritless manner han would suffice to acquire the theoretical knowledge in onjunction with the practical experience which we too often ind wanting, and the absence of which is excused on the plea that no time has been allowed for its acquirement. The time spent in putting things in order, seeing that everything is clean and in its place and ready for the next job, is about the best spent portion of the day. Nothing can be more idle or pernicious than the idea that it is beneath the dignity of a dispenser to do this kind of work for himself—it is only the sham gentleman who is afraid of losing caste by attending to those little things which really add so much to his own value. He who keeps his own department in nice order will soon learn to do his work with the least possible dirt, either to his appliances or to himself, and will add to his accuracy at the same time. The dispenser should be an accomplished man and a gentleman—up to every duty, and above none.

I might enlarge upon many points, but I hope I have said enough to be a useful hint to those who are willing to take it. I must now pass on to a few aids to dispensing.

There are many operations which may be conveniently performed in anticipation of their requirement, or may be facilitated by some preparation during leisure moments to save those more precious moments when business is pressing.

Salts are usually kept in powder, which facilitates their [redacted] is apt to agglomerate, forming lumps so hard as to give uble instead of saving it.

[ron mixture may be conveniently kept ready made, all the addition of the sulphate of iron, and should be alled in this style—

The addition of 2½ gr. sulphate of iron to
1 ounce of this mixture, makes
MIST. FERRI CO. B.P.

he dry ingredients of chalk mixture may be kept mixed, labelled—

One ounce of this powder with
7½ ounces of cinnamon water, makes
MIST. CRETÆ CO. B.P.

he formulæ for various preparations not very often ted, or which do not keep well enough to be worth ing in anticipation of the requirement, may be kept ten out for different quantities, to save calculation or the ces of error, by having the same to do in the hurry of ness. Thus—

Mist. Guaiaci.

℞ P. resin guaiaci .	½ oz.	88 gr.	11 gr.
Sacchari . .	½ oz.	88 gr.	11 gr.
P. G. acaciæ . .	¼ oz.	44 gr.	5½ gr.
Aq. cinnamomi .	20 oz.	8 oz.	1 oz.

Confectio Piperis.

℞ P. piper nigr. . .	2 oz.		44 gr.
P. carui . . .	3 oz.		66 gr.
Mel. despumat . .	15 oz.		¾ oz.
	20 oz.		1 oz.

he selection of the formulæ which it is desirable thus de depends, of course, upon the demand there may be for or other of the preparations.

t is also convenient to have some extracts, such as colocynth, aloes, and rhubarb, and some pill masses, such as rhubarb, assafœtida, and compound calomel, in powder as well as massive. The extracts, however, it must be remembered, are in some cases injured by drying, becoming less soluble, and probably less active.

The most important of all these aids to despatch are the concentrated infusions and decoctions. Unfortunately, they are not sanctioned by the authorities; and whatever may be their medicinal value, they are not readily made to have precisely the same physical qualities as the fresh; but while in theory almost every one prefers the fresh infusions, in practice almost every one will more or less frequently use the concentrated. I will not attempt to teach you to make them, but must remark in passing, that none should be used which do not afford a pretty close representation of the fresh as determined by a comparison with a sample of fresh made for the purpose.

We may now suppose your dispensary is in order and a customer presents a prescription. Your first duty is to read it, which must be done accurately yet so promptly as not to leave any impression upon the mind of the patient either that it has been carelessly written or that you are dull in when it can be done, even if it be only to confirm your own eading; and when you have hit upon a probable interpretaion, see that it agrees in all respects with the other part of he prescription—*first, as regards the style of the letters; then, s regards the nature of the medicine; and finally, as regards the uitability of the dose.* If, after all consideration, a safe and atisfactory conclusion cannot be arrived at, an appeal to the rescriber may be necessary, and care should be taken not to give any avoidable alarm to the patient. It is best to see the doctor without the patient knowing it. If the doctor is not within reach, a candid, open confession of the difficulty is sually the best course. Sometimes the patient himself can id, if he has had the medicine before, and can say what it was like, or what it is for, &c. In all cases of doubt or difficulty, when overcome, a note should be made to avoid the ame doubt occurring a second time. Some pharmacists make a practice of keeping doubtful prescriptions and giving the patient a copy; others make a marginal note to indicate their reading; a third class will copy the prescription, making a note in the prescription book. Whether the first and second be approved or not, the last should never be neglected. Whether the difficulty be in reading or dispensing, the precription book should contain such notes as would prevent any hance of making a repetition different from the first.

Labelling should be done in a neat, plain, legible style, withut any attempt at ornament or flourish, and should state riefly and clearly what is necessary, with the native idiom nd conventional expressions.

Weighing.—The dry materials of a mixture should be carelly weighed. Such a thing as guessing an ingredient should e so far from your thoughts as not even to require the ought that you will not do it. The scales should be kept in ood condition, the pans always clean, and wiped out after ach time of using. Any material apt to act upon the pan hemically, or to adhere to it, should be weighed upon paper. or this purpose take a piece of smooth paper, double it, and while double cut it with scissors into two circular pieces, which will now be placed one on each scale pan, and will no doubt balance one another. The weight being placed on one paper, and the material being weighed on the other, the weighing will be effected accurately without the material touching the pan. This mode should be adopted for soft extracts, deliquescent or corrosive salts, and for iodine. Much trouble will be saved in the end by the use of this simple precaution.

Measuring.—The fluid ingredients of a prescription are always estimated by measure, unless specially directed to the contrary. The ounce or drachm mark without the "fl." before it, literally means an ounce or drachm by weight; but if an ounce each of ether and chloroform were prescribed thus—

℞ Æther . . . . . . ℥j.
Chloroform . . . . . ℥j.
M.

a fluid ounce would be understood, though the fluid ounce of ether weighs $\frac{3}{4}$ oz., and the fluid ounce of chloroform weighs $1\frac{1}{2}$ oz.

Graduated measures usually have, and ought always to have, graduations on both sides; and in using the measure it should ım was greater than an ounce of water, because the ity of the tincture was less and its general surface ıearly corresponded with the ounce graduation; in rcumstances a measured ounce of any liquid varied as llarity varied from that of water, but now the rule ıwn by the Board of Trade is that the graduation correspond with the general surface of the liquid, and ısured ounces should be all equal. In measuring an ɔf laudanum, however, it is almost impossible to see eral surface; it has to be guessed at, and it is quite ·icable to see the graduations at the back of the glass h the liquid. Though the introduced change was ›d to be an improvement, it will probably lead to less ·y than before.

he old method we had to submit to the error arising ıriation of capillarity, but had a better chance of seeing ely when the graduation at the front of the glass onded with the required part of the liquid; we could t the graduation at the back of the glass corresponded same time, and consequently insure that the glass was l and the quantity correct within a small definite

the new method we can insure the absence of errors ıg from capillarity when measuring clear colourless , but with dark preparations we can scarcely see the ıondence between the liquid surface and the front ıtion; we lose sight of the back graduation altogether, e liable to the greater error arising from our having no to the vertical position of the glass.

en a number of fluids have to be measured into a e, the dispensing bottle should be carried in the right o the different parts of the establishment where these are kept, the measure glass being held between the and the forefinger and second finger of the left hand, ıe prescription between the two middle fingers of the nd.

The dispensing bottle may then be set down beside the stock bottle of the tincture or infusion required, while the stock bottle is lifted by the right hand, and its stopper removed by the little finger of the left hand. After the quantity has been measured, the stopper may be replaced, the bottle returned to the shelf, and the dispensing bottle being again lifted by the right hand, the contents of the measure transferred to it. In this way a succession of quantities may be accurately measured with the least possible consumption of time, with the prescription always under the dispenser's eye, and without any stock bottle being carried away from the part of the shop which it usually occupies.

By attention to such little points as these, accuracy, order, and quickness may be much promoted.

We will now turn our attention to a variety of cases which, occurring to me in actual practice, have presented some little difficulty, and which will sufficiently serve to illustrate what is likely to be met with by any one who has much dispensing to do.*

℞	Mist. amygdal.	gtt. xvj.
	Acid. hydrocyan.	℥viij.
M.	Capt. cochl. ij. bis vel ter die.	

pose that half a drachm had been intended, or to see the sician and make sure of the half ounce being his intention. h a dose is not officially recognized, and not commonly cribed; but we must also add is not dangerous, and is sionally given; it may therefore be dispensed as written ıout question.

℞	Sp. æth. nitros.	ʒiiss.
	Chlorodyn (C.B.)	gtt. x.
	Vin ipecac.	♏. xx.
	Aquæ camph., ad	℥ij.
M.	Ft. Haust. hora somni sum.	

31,886.

a this draught the dose of spirit of nitre is larger than l, the British Pharmacopœia dose being ʒss. to ʒij.; but need give no uneasiness, as the excess prescribed is not e, and the preparation is not a dangerous one.

℞	Magnes. carbon.	ʒiij.
	Rhei pulv.	ʒj.
	Zingib.	℈j.
	Tinct. card. co.	℥j.
M.	Capt. cochl. iij. omni mane.	

his is an evident case of omission of the excipient; but e being no clue to the nature of the material which was to bulk to the mixture, and no clue to the bulk intended, e was no course open but to see the prescriber and ascer- that "Aquæ ℥vij." had been omitted.

℞	Potass. iodid.	ʒj.
	Magnes. sulph.	ʒvj.
	Inf. quassiæ, ad	℥viij.
	Syr. aurant.	℥ss.
	Aquæ, ad	℥viij.
	Sumat. ℥ss. ter die.	

28,250.

his is an equally clear case of adding water when it was ecessary, and as it was evidently the intention to make an . mixture, the infusion of quassia was added in sufficient ntity for this purpose, and the water simply omitted with- troubling the doctor or patient about the matter.

℞	Mur. hydrarg.	gr. ss.
	Mur. ammoniæ	gr. v.
	Extr. belladonnæ	gr. viij.
	Alcohol	ℨj.

Tere simul et adde aqua bullient ℥viij., et cola per chartam.

20,007.

As a lotion to the eyes.

In this prescription the question arises what is "Mu hydrarg."? Though in most cases it would be understood calomel, there is here no question that corrosive sublim was intended, the "Mur. ammon." being added to prom its solution. Calomel would have remained undissolved, a consequently separated by the filtration.

℞	Hydr. chlorid.	gr. ij.
	Extr. colocynth co.	gr. viij.

Misce, fiat pilula sumat duo pro re nata.

Mitte xxxvi.

20,149.

The quantity ordered here to make a pill being unusually large, it was a question whether it had not been the intention of the prescriber to insert a number—say 2 or 3—after the word pilula. The patient being a lady not in the habit of taking very strong medicine, this was decided upon, and it was made into two pills as the most likely.

lsion, or other remedies for cough, hydrocyanic would be
rstood; always, however, having regard to the propriety
e dose. "Inf. sen." may be infusion of senna or of
ga, and to determine it we shall be guided by the
ability of a purgative or an expectorant being intended.
tass. sulph." may be sulphate or sulphuret. If a few
s are ordered internally, sulphate would be our reading.
oz. were ordered for a bath, sulphuret would no
t be the intention. "Sodæ carb." is generally under-
to be "Bicarb.," but I once met with a case where
læ carb. pulv. ℥ij." was ordered for a bath, and as the
"Pulv." was doubly underlined, it was supposed to
ate that the carbonate was to be used which is not
lly kept in powder, *i.e.*, the monocarbonate, not the
bonate.

stead of further multiplying examples, I will just add a
ion, never to overlook any circumstantial evidence which
throw light upon instructions which in themselves are
sufficiently explicit.

fter the task of interpreting the prescriptions comes the
lem of how to mix the medicine in a suitable condition.
inary mixtures rarely present any difficulty; but as ex-
ions will be met with occasionally, I will adduce a few
trations, together with a few general hints on convenient
hods of mixing.

ur aim must be to make the mixtures uniform—that is, the
e mixture should always have the same effect; it should
, taste, and smell the same, and there should be little or
difference between the first dose the patient takes and
last.

oluble substances should always be dissolved before the
licine is put into the patient's hands, *except* when there is
e than can be retained in solution at ordinary tempera-
s. The use of warm water is often a great convenience
xpediting the solution of such salts as chlorate of pot-
borax, or alum, which only dissolve slowly; but if the

mixture can only retain a portion of the salt in solutio when it is again cold, the remainder will be deposited crystals on the side of the bottle in a condition in which will be almost impossible for the patient to take it. If, ther-fore, the salt be in excess of the solvent, it must be reduc to the finest possible state of division, and the direction shake the bottle must be added.*

I have here two mixtures containing 1 oz. bicarbonat of soda in 8 oz. of water, one of which was made with hot water and complete solution effected; as it cooled, however, a portion of the salt was deposited in crystals on the side of the bottle in a most inconvenient manner; the other was rubbed as fine as possible with cold water, and was while new (two years ago) as good a mixture as could be made of the materials. I showed it to you last year, and it had then become knotted and hard with twelve months' keeping. You will observe, now that it is two years old, it has become distinctly crystalline.

It would be well for medical men to make a rule as far as practicable to give soluble substances in a sufficient quantity of solvent to retain them perfectly in solution at ordinary temperatures; but as we cannot regulate this point, our next

31,734.

℞	Morphiæ hydrochl.	gr. j.
	Acid acet. dil.	♏ xv.
	Liq. ammon. acet.	℥j.
	Aquæ, ad	℥ij.

M. Ft. Haust. sumat, ℥j. omni nocte.

The addition of acetic acid in this case is no doubt intended to insure the freedom from carbonate of ammonia which might be present in the acetate of ammonia if not accurately neutralized, and which would precipitate the morphia. If the addition of 15 drops of diluted acetic acid failed to make the liquor distinctly acid, it would be legitimate to add more, following the spirit rather than the letter of the instruction.

℞	Sodæ boratis	℥ss.
	Morphiæ hydrochlor.	gr. vj.
	Aquæ	℥viij.

M. Ft. lotio.

The two salts being dissolved separately and mixed, the morphia was precipitated. Being an external remedy it was not unsafe, and was supplied to the patient in that condition, and a note was sent to the prescriber informing him of the decomposition, that he might, if necessary, modify this combination in subsequent prescriptions.

Distilled water should be used as a regular habit; there are many cases in which it makes no important difference in the medicinal value of the mixture, but on which it still makes a difference in the appearance, and we must remember that the appearance will sometimes have a great influence upon the patient, and it is well, when our work is called in question, to be able to show that our practices will bear the strictest investigation. Infusions and sundry other clear preparations made with distilled water will give no precipitate with alkaline carbonates; but if hard water were used, carbonate of lime would be deposited, and the patient, getting his mixture clear at one place and turbid at another, would naturally suspect that the latter was carelessly made or of inferior materials. I have here three mixtures illustratin this point.

℞. Sodæ bicarb. . . . . . ʒss.
Aq. . . . . . . ℥iv.
M.

This being made with hard water is turbid; had it b made with distilled water it would have been bright. If patient were to show me the prescription and ask the question I could not deny that the preparation was at fault.

Take another:

℞ Liq. arsenicalis . . . . ʒj.
Liq. potassæ . . . . . ʒss.
Aq., ad . . . . . ℥iv.
M.

In this case I have two mixtures, one made with "Aq. font." and the other with "Aq. dest." You observe the latter is quite bright, but the former contains a dirty pink sediment, which the patient will say is the arsenic not properly dissolved. You will say it is carbonate of lime previously held in solution in the water by excess of carbonic acid which the potash has abstracted; and the lime salt has gone down in combination with the colouring matter of the liquor arsenicalis. You must admit, at the same time, that it should not lour might have been changed in his previous supplies by e use of hard water. I mixed a little of the tincture in o glasses, one with hard and the other with distilled water, d showed a difference in tint, and thus established his conence in my accuracy. But enough of this: use distilled ter at all times.

Some vegetable powders, such as rhubarb and ginger, if iply put into the bottle with a watery excipient, are apt to nain for a long time in dry knots, to avoid which they may rubbed in a mortar with a small portion of the liquid; or, ving been rubbed smooth, without moisture, but advangeously with any saline ingredient, they will mix readily if nply put into the bottle half full of water or infusion and skly shaken. The froth formed in this way is sometimes oublesome, especially with decoction of aloes or sarsaparilla. a tincture is to be added, this will usually extinguish the oth; if no tincture is contained in the mixture, it may be oured through a funnel into another bottle, and the froth will main behind; but it is better to avoid making the froth, hich may be done by using so little of the fluid to shake the owder with that it makes a creamy consistence first, which ay be afterwards diluted without agitation. Or the mixing ay be effected in a mortar. Or, if a tincture be present, the owders may be diffused in it first without the liability of othing, and the aqueous fluid added afterwards. Ginger id other oily and resinous powders mix with spirit much ore readily than with water; but pure resins, soluble in irit, are apt to run into adhesive lumps if put into spirit, hich they are not liable to if put into water. Whatever the wder may be, it is best to put some fluid into the bottle st, that the dry materials may not stick to the bottom.

There are many mixtures which undergo some slight ange, such as the deposit of a resinous matter from a tincre when it is added to an infusion; in such cases it is the stom of some establishments to filter the mixture before is sent out—a practice, however, which I must strongly condemn, as valuable constituents may frequently be t removed. This is the case when tincture of Indian hem added to water, or tincture of quinine to infusion of ro also when spirit of juniper, or other solution of essential oil is added to a watery fluid. It would be better if medical men would avoid ordering mixtures of that kind; but, when ordered, the pharmacist's duty is to make them up as directed however unsightly they may appear, and not filter unless he is directed to do so.

℞	Tinct. belladon.	ʒj.
	Syrup. ferri iodid.	℥j.
	Potass. bicarb.	ʒj.
	Aqua camph., ad	℥vj.

30,119.

The above mixture was probably prescribed unmindful of the decomposition which would occur; but if the pharmacist were to filter it on the ground of its not being intended to contain a sediment, he would be taking an unwarrantable liberty with its therapeutic action.

When spirit of nitrous ether is ordered with iodide of potassium, a small but uncertain quantity of iodine is always liberated from the action of free acid contained in the spirit of nitre, to avoid which the nitre may be first neutralized with rrh and ammoniac, are also made by simple trituration e dry material with water gradually added; attention d be given to the condition of the gum—fresh, soft, ɔsy" gums making the best emulsions. Powdered or gum-resins should not be used.

stor oil, almond oil, and balsam of copaiba are emulsified e aid of gum, alkali, or soap, or the use of both gum lkali.

e mixture is most perfectly effected when the oil and are present in about equal bulks. The best mode of ting is to put the gum and water or mucilage into a ır, and add the oil or balsam by degrees, with brisk ng; if the mixture becomes thick with the addition of il, water should also be added before more oil, so as to tain the emulsion during its formation at about the stence of a thin cream. When the mixing has been effected, the remainder of the liquids are to be added, g care that tinctures are added last, as they are liable to the separation of the emulsion into its constituent fluids. ı emulsion may be made with less trouble, though not so perfectly, by putting the oil or balsam into the bottle powdered gum, shaking them together till mixed, which place very readily, then adding about double the bulk ıter, and shaking briskly.

kaline emulsions are usually made without the mortar ıtting into the bottle the alkali with a measure of water to the oil which is subsequently to be added; emulsifac- may then be effected by brisk agitation, the remaining being gradually added.

ıuid extract of male fern is frequently prescribed with age, with which it does not make a very satisfactory ıion; a better form of administration is to emulsify the t with a little alkali, or soap and mucilage, before adding ılk of the vehicle. There appears to be some prejudice st the use of soap in making emulsions for internal use; ght, however, be much more frequently applied with advantage, and the olive oil soaps are now made so free from objectionable taste as to be quite suited for this purpose.

When soap or alkali is used along with mucilage, the acidity of gum arabic must not be overlooked, as it interferes with the effect of the alkaline constituent; and it is well to keep in mind that a few grains of tragacanth will nearly equal in emulsifactive power as many scruples of acacia, and will not trouble us with acidity. Many other mucilaginous or colloid bodies may, under special circumstances, be used for this purpose—quillai bark and albumen among the number; but excepting the latter, it can scarcely be said that any of them possess any advantages over the two familiar gums.

Mixtures analogous to emulsions frequently occur from the addition of resinous tinctures to water; the separation of the resin in a sticky condition, in which it may cohere into lumps or adhere to the bottle, will frequently be the result if gum be not added, while a permanent emulsion may be obtained by its use.

Take the following as examples :—

℞	Ammon. hydrochlor.	ʒij.
	Potass. chlorat.	ʒij.
	Tr. laricis	ʒiij.
	Pulv. tragacanth	℈i.

add half the water, shake again, and then fill up with the remainder of the water.

The next prescription is an example of the difficulty arising from want of gum.

℞	Mist. camph.	℥vij.
	Tinct. camph. co.	ʒj.
	„ benzoin	ʒiij.
	„ scillæ	℥ss.
M.		

The gum benzoin separated as a clotted mass, in a condition quite unfit for the patient to take; and this was the same whatever mode of mixing was adopted, until the expedient was tried of adding 20 grains of powdered tragacanth to the mixed tinctures, and then adding the water with brisk agitation. A perfect emulsion was the result. On showing he two mixtures to the prescriber, he most willingly sanctioned the addition.

Though powdered gum may be added to alcohol without any fear of its becoming knotted, the case is somewhat different with mucilage; if the latter be poured into strong pirit, the gum separates in clotty adhesive flocculi, though he mucilage will bear a considerable addition of spirit, if he spirit be poured in gradually while the mucilage is kept tirred. We avail ourselves of this in making such mixtures as the following :—

℞	Tinct. guaiac. am.,		
	Mucilag. acaciæ	āā	℥j.
	Potassii iodidi		℈ij.
	Tr. arnicæ		ʒiij.
	Decoct. cinchon., ad		℥viij.
M.			

The mucilage is to be put into the mortar, and the tincture dded by degrees with constant stirring. When about a hird of the tincture has been thus added, the mixture is hicker than the original mucilage, and should have a small ddition of the decoction of bark to thin it, and then more of he tincture. In this manner the whole of the guaiacum may

be suspended without any of the acacia being precipitated; t
other ingredients being added, a perfect mixture is formed.

Another mixture of a similar nature was found to work better by a slightly different treatment.

℞	Tinct. guaiac. am.,		
	Mucilag. acaciæ	āā.	ʒiv.
	Inf. cascarillæ		℥vij.
M.			

When this was mixed as above it left a black deposit of gum, but by putting the mucilage in the bottle with an ounce of the infusion and adding the tincture by degrees, shaking after each addition, a satisfactory emulsion was produced.

White of egg and yolk of egg are both used for converting essential oils into emulsions with watery fluids for use as liniments. The following is a form we have many times made, and fairly represents the class:—

℞	Ol. terebinth	ʒss.
	Ol. origani	ʒiss.
	Vitelli ovi	q.s.
	Liq. ammon.	ʒiij.
	Aceti	℥iv.
Ft. liniment.		

The yolk of egg is best rubbed in the mortar with the ammonia first, the alkali helping to dissolve down any stringy particles. When this is sufficiently accomplished the oils are

QUESTIONS FOR EXAMINATION.

an ambiguous word or quantity occurs in a pre-
, how would you determine which of several readings
nost probable?

ounce of chloroform be ordered in a prescription,
; be dispensed by weight or measure?

. find a medicine ordered in doses larger than usual,
siderations would guide your proceeding?

rule should be observed in dispensing soluble salts
res?

rule should be observed regarding the filtration of
?

advantages are there in the use of distilled water?

RECAPITULATION.

; of order and of observation are most important to
nser.

an ambiguous word occurs in a prescription, and a
reading has suggested itself, compare it with the
rts of the prescription as regards the form of the
ıe nature of the medicine, and the suitability of the

difficulties are overcome, make such notes as will
their recurrence.

pensing, all fluids except mercury are estimated by
unless the contrary is indicated; as a rule, "solids
ıt, liquids by measure."

ict rule can be laid down regarding over-doses. Doses
an usual may be dispensed as written if they do not
langer to the patient; any dose apparently unsafe
e corrected or confirmed by the prescriber before
spensed.

When a contracted word is capable of two interpretation judge of the drug by its companions.

Soluble ingredients in a mixture should be entirely di solved before the mixture is sent out, provided they wi remain in solution under ordinary keeping.

Mixtures naturally turbid should not be filtered unle instructions are given to that effect.

Distilled water should be habitually used in dispensing.

LECTURE XXI.

READING AUTOGRAPH PRESCRIPTIONS.

been my custom in previous sessions to show you a tograph prescriptions, and make a few brief remarks em, in my lecture on Dispensing Mixtures; but the at could in that way be devoted to it was much too onsidering the importance of the subject and the terest which has been shown in the study of such ns. I therefore now propose to devote an entire to the reading of autographs.

selection to which I shall direct your attention has de from my small collection mainly with the view of fying the modes of clearing up ambiguities of difatures. Some have been added simply as exercises in diverse handwritings. A facility in this art is only l by practice, and is often found wanting in the tes for examination who go from situations where ispensing is done, or where the prescriptions are xclusively from the hands of two or three practi-

who habitually see a diversity of styles will scarcely et with English prescriptions which they cannot read. ction does not contain the most difficult prescriphave met with, which have usually been German, ld have proved less instructive and less practically han those which are simpler in their nature; and digenous to our soil, will more fairly represent what every dispenser may expect to meet with, and should be prepared to read. The selection is made entirely from prescriptions which have been brought to me in the usual course of trade, and is only a small percentage of the number of those which might have afforded interesting points for comment. Patients usually object to parting with their autographs, and I have been limited to such as have been left in my hands generally by accident, sometimes by permission, and a few tracings which I have made with every care when I could not retain the originals.

As a matter of course, the superscriptions and subscriptions have been withheld, but in other respects the lithographer was instructed to copy them with every possible fidelity, neither adding nor subtracting any mark or spot which could influence for better or worse the intelligibility of the originals, and he has accomplished his task with remarkable exactitude.

From my familiarity with the selection, and many more of a similar character, the difficulties to me have in most cases entirely disappeared, and I feel that some apology may be needed to the more skilful among my readers for presenting such as will scarcely tax their skill; but, on the other s further illustrations of style, without involving such ties as call for special comment; of these I have given my reading.

not offer any comments upon prescriptions rendered)nally obscure with the view of their being dispensed) particular establishment. I am happy to say I have rely met with such, and do not think them worthy of

Of those which are intended for general reading, a ıall percentage—not more than one or two in a thou- give real trouble to an experienced dispenser, a propor- no means large, considering the circumstances under nedical men are frequently compelled to write. Few ıve the faculty of writing well when hurried. Under ircumstances, the characteristics which always mark a handwriting may become so exaggerated as to render guous to one unacquainted with the usual style of the while those who are acquainted with his caligraphy experience no difficulty.

No. 1.

Master D.

℞	Linimenti Opii	ʒvi.
	Linimenti Camphoræ Comp. . . .	℥ii.

M. Ft. Lin.

"Sign" For external use only.

Oct. xxiv. 63.

y of the letters in this prescription are badly formed, the words are written in full, there can scarcely be be any difficulty in reading it. Physicians who take able to write their words in full scarcely ever give the er room for a misunderstanding.

No. 2.

ase to keep this prescription, and not give a copy of it to Mr. B.

℞	Quinæ disulphatis	gr. xxx.

instilla e limone recente quantum sufficit succi ad quinam solvendam et adde,—

Aquæ	℥x.
Strychniæ	gr. i.

M. fiat mistura cujus sumat cochl. i. maximum bis die circa 11mâ A.M. et 4tâ horâ P.M.

No. 2 is a well written, and at the same time an interesting prescription, written by a physician of high standing for a patient of equally high standing, the latter being kept in the dark as to the nature of the medicine he was taking; the physician's instruction being that the patient was not to have a copy of the recipe, the patient supposed himself to be taking some simple bitter. There is a chemical oversight on the part of the physician; though he carefully directs lemon-juice to be dropped upon the quinine in a quantity sufficient to dissolve it, he then simply says, add 10 oz. of water and 1 grain of strychnine. A drug like strychnine, which is very powerful and not very soluble, should have had more explicit instructions to insure solution, or otherwise a careful distribution of the doses. Had the care of the dispenser not been greater than that of the prescriber in this particular, the patient might easily have had a serious overdose when he came to the bottom of his bottle. Ordinary silver tablespoons of the present day usually hold about 1 fluid oz.; if the mixture were made to measure 10 oz. or 11 oz., and the patient took such a tablespoonful for a dose, he would be taking rather more than the maximum dose according to the Pharmacopœia. As the physician uses the superlative degree he quantity; the latter precaution is always desirable, and hould never be omitted when a full dose of a powerful drug s ordered.

No. 3.

	Inf. Salveae	℥viii.
	Muriat. ammon.	ʒii.
	Mell. rosarum	℥iss.
(M.	ft. collut. oris [erased]).	
M.	ft. gargarisma utatur saepe de die.	

Servant of Mr. Anderson.

The first line in this prescription may give a little trouble o any one not acquainted with the handwriting. This rises simply from a slight peculiarity in the form of the "v," nd is cleared up by comparing the same letter in the word Servant" and in "Lavand." occurring in No. 12. The ss" following "Mell. rosarum" should also be noted, eing a little different from the usual form of this symbol, nd may aid the interpretation of any similar mark when net with. The remainder will give no difficulty.

No. 4.

℞	Ext. Aloes Co.		
	Ext. Hyoscy.		
	Pil. Rhei Comp. . . .	āā	gr. iſs.
M.	ft. Pil. om. nocte Cap.		
			Mitte xiv.

℞	Dec. Taraxaci		
	Inf. Gent. Comp. . . .	aa	℥viii.
	Sodæ Bicarb..		℥ſs.
	Bismuth Tris. Nit.		ʒii.
	Capt. ℥i. bis. die.		

℞	Ol. Croton. Ol. Olivæ		
	Spt. Tereb.	āā	1 dr.
M.	ft. Lin. om. nocte affr.		
	Oct. 16, 67.		

We could scarcely find a fault with the writing of this cipe; the only words about which a tyro could hesitate are Tris." in the bismuth, the "Spt. tereb.," and "Affr." But aving mastered these, we are still in doubt as to the intenon of the first line. What is compound extract of aloes? Pil. aloes co." and "Ext. aloes aq." are two readings which naturally suggest themselves in the absence of any know formula for a compound extract of aloes. The former o these, made as it used to be with aloes and extract of gentia was judged the most probable, and as it was at any rate safe interpretation, it was acted upon without further cer mony.

No. 5.

℞ Ferri Biphosph. . . . . gr. xx.
Sacchar alb. . . . . ℨii.
Aquæ . . . . . ℥ii.
Cochl. i M. bis die.

The adjective qualifying "cochl." is, no doubt, "m."; b whether it is min., med., or mag., we are left at our discretion to determine. The mixture being prescribed for a child, and in quantity of only two ounces, a teaspoonful was the translation fixed upon.

No. 6.

Mrs G.
℞ Pulv. Opii. comp. . . . . gr. x.
ft. Pulv. post sing^{e} deject Liquid sum.
Mitte vi.
Aug. xiii.

This illustrates the difficulty which is sometimes found in

No. 7.

℞. Extr. Taraxaci . . . . . gr. xxxvi.
Fell. bov. inspiss. . . . . . gr. xxiv.
M. ft. pil. xii. Capt. 1 ter die.
Mrs. O. B.
June 29, 1863.

No. 8.

Miss E.
℞ Extr. Aloes aquos . . . . . gr. ¼.
Ferri Sulphat. . . . . . gr. ¼.
Extr. Hyoscyami
Gentian . . . . āā gr. ii.
ft. Pilula semel vel bis die capienda × xii.
Die Aprilis 23, 1856.
× at meal times.

his may be taken as a specimen of good writing. As it ɘ from the hand of the physician, it probably did not ent the shadow of an ambiguity. The one point which ires comment is the mark × which follows "capienda." 'as there, and not crossed out, when first the prescription e under my notice; and when, after an interval of some ths, during which it had been dispensed in several other ns, it was presented again, the × was crossed out with il, and a pencil mark xii. was placed after it, indicating some dispenser had interpreted the × as ten. We can cely suppose that he read it ten pills once or twice a day, probably supposed that the physician intended "Mitte ×," the dispenser had preferred to make 12 as a more convet multiple of the quarter grains. But a little considera- will show that the × is intended for *, referring to the note—"× at meal times." This, as it appears to be in ther handwriting, has probably been added by the patient,) was no doubt quite unconscious that adding × after a d might have multiplied her dose by ten.

No. 9.

℞ Extr. Belladon. . . . . . gr. iss.
Butter of Cocoa . . . . . q. s.
M. ft. supposit., p. r. n. utend . . . viii.

℞ Acid. Carbolic . . . . . ʒss.
Glycerin . . . . . . ʒiiss.
M. Use 10 drops.

No. 10.

Hab. Tinct. Iodin. C. . . .	ʒiv.

Sig. The Iodine paint for external application.

July 13, —68.

No. 11.

Mrs S. Baby.

℞ Hydr. c. Creta	gr. i.
Pul. Cretæ co.	gr. ii.

M. ft. Pul. omni nocte sum. Mitte xii.

June 7, —57.

Nos. 9, 10, and 11 do not call for any particular rema

No. 12.

℞ Spirit lavend. comp. . . .	ʒiv.
Spirit nitri dulc.	ʒii.
Laudani	ʒii.

M. Sumat bis de die 20 guttas.

This autograph is useful as enabling us to compare the in “Lavend.” with the more doubtful “v” in “Salviæ No. 3, by the same writer.

No. 13.

℞ Tr. Ferri Muriatis	ʒiii.
Lq. Arsenicalis	ʒiss.
Magnes. Sulphatis	ʒi.
Aquæ	℥viii.

℥ss. t. d.

℞ Zinci Ben.

nainder of the word. “Magnesiæ sulphatis ℥j.” and Aqu. ℥viij.” are as clear as need to be. The directions ss. t.d.” also need not give any trouble. But by the time mixture was ready for the hand of the patient, who was iting, I had not made up my mind how to read the last a. The mixture suggested a skin disease, and this pointed zinc ointment as being the most probable interpretation of last line; but the matter was not so certain as to let me l comfortable in supplying it with the chance of its being ong. I therefore ventured to ask the patient if the doctor l instructed him with regard to the use of ointment. To ich he replied, “Yes, he told me how to use it,” and then upplied a pot of zinc ointment without the doctor having n troubled or the patient knowing that I had felt any itation about it.

No. 14.

Mrs C.

℞	Pulv. Doveri.	gr. vi.
	Hydrarg. c. Creta	gr. iv.

In pil duas statim sumendas.

℞	Magnes. Ustæ	ʒss.
	Pulv. Rhei	gr. xv.
	Syrupi Zingib.	ʒss.
	Tinct. Zingib.	M. xx.
	Acid Hydrocyan. Dilut.	M. v.
	Aquæ	℥ii.

Haust post horas duas sumendus.

The word “Ustæ” is not very clearly written, and not eing in constant use now as indicative of calcined, may ive trouble to some of our younger friends; the last few nes become somewhat confused for want of space, but should ive no trouble if attacked in detail.

No. 15.

The Rev. Ernest T.

℞	Hydr. Bichlor.	gr. i.
	T. Opii	ʒss.
	Inf. Quass. conc.	℥i.
	Aquæ	℥i.

Cochl. 1 min. ter die. ex aqua.

℞	Pulv. (?)	gr. v
	Bismuth	gr. iv.

ft Pulv. o. n. . . . . . Mitte vi.

In the first line of this formula the quantity is undoubtedly 1 grain, though the symbol would equally well represent ℈j., and we are guided entirely by the dose which would be appropriate. The consideration of doses constantly comes to our aid in clearing up difficulties, not only in regard to the interpretation of ambiguous quantities, but frequently in cases where the drug itself, or the special preparation of a drug would, in the absence of this aid, be a matter of doubt. Take for example the next line; the drug is opium, and the quantity is half a drachm, for sixteen doses, one thrice a day. Now the prefix to "Opii" looks more like P than any other letter in the alphabet, but this would make the dose nearly two grains of opium thrice a day, a very unlikely dose, especially associated with an ordinary alterative, and comparing the doubtful letter with T in "The" and the initial of the patient's name (which, however, looked more like Jones than anything else, until in reply to my inquiry he gave a name beginning with T); thus all things considered, there was no doubt left that "Tinct. opii" was the intention, and this is supported by the notable difference in the mode of writing "Pulv." in the second half of the prescription.

'here are several points in this which I failed to solve sfactorily, but which I thought of little moment, as there eared no ambiguity about the ointment or directions. first illegible word no doubt means mix, but what is precise writing I am not prepared to say; the second eared to be the name of a hotel, and the third the ature, so the ointment was made without any hesitation; the patient said my production was quite different from t he had in Germany, the latter being brown and smelling tar. No doubt oil of juniper tar was the intention, and iciently well understood in the prescriber's own neighbourd.

No. 17.

Mrs D.
℞ Acid. Nitrici. . . . . ʒiii.
Syr. Simpl.
Tinct. Aurantii. . . . . āā ℥ii.
M. Capt. cochl. Th. 1 bis die ex cyath vinos aquæ.
Die Nov. xx. 1852.

'he greatest difficulty here is to read the words "Cap. il.," the want of clearness arising mainly from the two ds being run into one. The dose may be taken for a teaonful if the letters indicating it be "Th," but it is quite ibly intended for M., in which case the dose may be a poonful, a dessert-spoonful, or a table-spoonful, the first he most suitable dose; the dose of strong nitric acid g about 2 to 5 minims, the dose in the prescription g about 6 minims if the mixture is made to measure z., or little more than 5 minims if made to measure z. and 3 drachms. This appeared sufficiently within nary experience to justify the mixture being made hout writing to the physician at a distance to have it firmed; but to the patient's alarm, the cork was blown of the bottle with the evolution of nitrous fumes, and bably the conversion of part of the sugar into oxalic l. If diluted nitric acid were intended, I would alter my ling of the directions thus, "Cap. cochl. mag. i. bis die," &c.

No. 18.

℞ Carb. Ferri. Sacch.	gr. viii.
Pulv. Aromat.	gr. ii.
Carb. Sodæ Exsicc.	gr. iv.
M. ft. Pulv.	Doses xii.

Sig. Stomachic Powders. one in a little gruel twice day.

This was written by one physician for another, the patient bringing it to us with the declaration that he could not read it; but all the difficulty disappears after a careful examination. In the second line, the letters are evidently not exactly as I have rendered them, but we have only to suppose that it was contracted as "Aromt." It is interesting to note, that with almost every one the chief difficulty has been in reading the directions which are written in English.

No. 19.

℞. Pilul. Hydrarg	℈
„ rhei co.	℈ii.
M. ft. Pilul. xii.	

Capiat ii. H. s. p. r. n.

℞ Magnes. Carb.	
Sodæ Carb.	
Magnes. Carb.	aa ℥i.
Aquæ	ʒviiss.
Vin Ipecac.	ʒi.
Tinct. Zingib.	ʒii.

rtainly occur by some accident, and the same may be the se in the former number. Folding before the ink was dry ay account for both. It appeared that the middle dot in e dose and the curling back of the tail of the latter figure the dose, had both occurred in such a manner. Neither terpretation would make the mixture last exactly the same me as the pills. Two was ultimately decided upon, and is nfirmed by the appearance of the figure when the middle ot and middle stroke are covered by a white thread.

No. 20.

℞	Chloral	grs. 120.
	Potass. Bromid.	grs. 180.
	Syrup. Aurantii	℥ss.
	Aq. ad	℥vi.

M. Capt. ℥i. omni nocte.

℞	Hydrarg. Bi. Chlor.	gr. ii.
	Extr. Belladon.	gr. vi.
	Conf. Rosæ	q.s.

ut fiant pil. xii. Capt. 1 bis die.

The official dose of perchloride of mercury is one-sixteenth one-eighth of a grain; this being one-sixth of a grain ice a day, seems a larger dose, but a comparison with other escriptions from the same physician showed that he was t unaccustomed to giving a full dose of this remedy; and e clearness with which it is written excluded any other inrpretation. The "ss." after the ounce mark on the third ne is not equally clear, but may be compared with another utograph by the same hand, No. 31.

No. 21.

Hyd. Bichlorid.	gr. ½.
Tinct. Cinch. Co.	℥i.
Aquæ	℥i.

Cochl. Min. bis die ex aquâ.

In this case the quantity in the first line might be taken for half a scruple, were it not that the consideration of a suitable dose clearly indicates that half a grain must be the intention.

No. 22.

℞ Ext. Elateri . . . . . . gr. ⅙.
Gum Opii . . . . . . gr. ¼.
ft. Pil.
Om Noct.

If difficulty were experienced in reading the first line of this formula, an appeal to the list of extracts in the index of the Pharmacopœia would not afford us the assistance which it usually does; but a comparison of the initial of the doubtful word with the "E" in "Ext.," will at once solve the problem, and the suitability of the dose puts it beyond all question.

In this case the second word, if isolated, might give some trouble to decipher, but there is no difficulty in deciding that the first word which follows the sign ℞ is Ext., and this guides us to the determination that the first letter of the second word is E, and then the others follow without any difficulty, "lateri." Had this not suggested itself as an evident reading, we would naturally have looked over the list of extracts to call to mind any which would be appropriate prescribed in one-sixth grain doses, and with the name which the ambiguous word could be supposed to coincide.

No. 23.

℞	Sennæ fol.	ʒiv.
	Mag. Sulph.	℥iss.
	Syrup Rhamni	
	Tinct. Jalapæ	āā ʒvi.
	Tinct. Zingib.	ʒii.
	Infuse in aquæ	℥vi.

℥iss. 2 dis horis donec alv. respondt.

ıe use of oil of vitriol as an adjunct to Barbadoes aloes scarcely be considered elegant pharmacy, and is now ınately of rare occurrence.

No. 25.

Mrs F.

℞	Potass Iodid.	gtt. ʒi.
	Ferri Am. Cit.	ʒiss.
	Aquæ ad	℥viii.

M. ft. Mist. cujus St. ℥ss. ter die.

ıe "gtt." preceding ʒi. in the first line is evidently sus, occurring, as these things frequently do, in conence of the patient talking to the doctor all the time he riting. It leads to no difficulty, and only needs to be d.

No. 26.

℞	Argenti Nit.	gr. iiii.
	Aquæ Distill.	℥i.

F. Lotio. Assid. app.

t first glance the word following aqua was supposed to "Fortiss," which it certainly resembles, but as it is to n a lotion to be applied assiduously, the word "distill." at once fixed upon.

No. 27.

℞	Liq. Plumb. Diacet.	℥ss.
	Acid Hydrocyan. Sch.	ʒi.
	Morph. Acetat.	gr. v.
	Aquæ ad	℥vi.

M. ft. Lotion. ℥ss. ex aqua utend.

℞	Sodæ Carb.	℥ss.
	Pulv. Rhei	gr. xxx.
	Tinct. Zingib.	ʒii.
	Spt. Ammon. Arom.	℥i.
	Tinct. Cardam. Co.	℥i.
	Infus. Gentian ad	℥viii.

M. Sumat. ℥i. quotidie ex aquâ.

No. 27 presents us with two or three symbols which are a little ambiguous. There might be some doubt as to whether the ounce or drachm symbol was intended in the quantity of lead solution, in the quantity of lotion to be used, and in the quantity of carbonate of soda ordered. In the latter case we find the quantity of rhubarb in the following line is written gr. xxx., and that the quantity of soda has been begun to be written in the same manner, but has been struck out, and would scarcely have been made to express the same quantity by another symbol. Then as regards the appropriateness of the two problematical quantities, the eighth part of half an ounce is a more usual dose than the eighth of half a drachm, and we conclude to read it ℥ss.

The question of appropriateness in the other two am biguous quantities will also lead us to conclude that they a both intended for ℥ss.

The word preceding "Zingib." appears to have b written "Pulv." first, and afterwards "Tinct." Thi confirmed by the fact that it is more usual to order ʒii tincture of ginger in an 8-oz. mixture, than the s quantity of powdered ginger.

No. 28.

umbæ," though the patient said it was not the same as ad had previously. The prescriber being at a distance, I ussed the possible readings of the word with the patient self, and satisfied him of my correctness. We could conclude that some other dispenser had put a different rpretation upon it, which, he admitted, it was quite ible to do. "Inf. quassiæ" seems the next in order of bability.* It is always a comfort in a case of this kind be able to assure the patient that the alternative is not a ngerous one.

No. 29.

℞	Bismuth. Trisnit.	ʒiss.
	,, Liquor	℥ss.
	Glycerin	℥ss.
	Liquor. Potas.	ʒii.
	Chlorodyne	ʒi.
	Acid. Hydrocy. dil.	M. 50.
	Extr. Belladonnæ	gr. vi.
	Tr. Calumb.	℥iss.
	Inf. ,,	ad. ℥x. M.

℥ss. ter in die Sd.

Empl. Belladonnæ Co.

5 inches × 4 margin adhesive inclusive.

Oct. 21/71.

No. 30.

℞	Magnes. Sulph.	ʒiv.
	Acid. Sulph. Dil.	ʒiss.
	Syr. Zingib.	℥ss.
	Tinct. Aurantii	ʒiii.
	Inf. Aurantii Co. ad	℥viii.

M. Capt. ℥i. ter die.

Dec. 4, 1872.

Dec. 9, 1872.

Rep. Mist. cum Magnesiæ Sulphatis ʒiv.
ad. ℥viii.

This may be considered a well-written prescription with exception of one word, "Zingib.," of which the letters

---

Since the appearance of this facsimile and the above comments upon have received letters from several pharmacists in Buxton, saying that were familiar with the handwriting and the custom of the writer, that the infusion is undoubtedly quassia and the acid "Fort." I allow omments to remain as originally written, because it is an instructive to note that a careful and reasonable consideration of the prescrip- esulted in the wrong conclusions.

"Z" and "g" are the two wanting in clearness. The initial does not occur in any other word in the prescription, so we have not the advantage of making a comparison; but as the preceding word "Syr." is clear enough, and we have only to consider the list of syrups to see at once that zingib. is the one which fits the occasion, and this may be confirmed, if necessary, by comparing the "g" with the same letter in the word magnesia, which occurs twice. The note at the foot might lead to the impression that the mixture was intended to have a further addition of ʒiv. magnes. sulph., but it will be noticed that the quantity of this salt originally prescribed on December 4 was ʒii., and the figures had been altered to ʒiv. on the repetition at the subsequent date; consequently we read it that the mixture is to be made with ʒiv., not with the addition of ʒiv.

No. 31.

	Chloroformi		M. xx.
℞	Magnes. Carb.		ʒi.
	Magnes. Sulph.		℥ss.
	Pulv. Rhei		℈ii.
	Pulv. Zingib.		ʒss.
	Liq. Morphiæ Mur. . . .		ʒij.
	Inf. Gentian . . .	ad	℥viii.

M. Capt. ℥ss. ter die.

ginger is indicated by one " s," not two; taking these circumstances all into account, we conclude that all the three figures are intended as abbreviations of the fraction " ss.," and the reading of the recipe is decided as above.

No. 32.

Miss E.

℞	Hydr. Chlor.	gr. xx.
	Tinc. Hyoscy.	ʒi.
	Aquæ	ʒix. M.

Draught to be taken at bed time.

Nov. 9/72.

We have here to note the ambiguity resulting from abbreviating the name of a drug. For many years the translation of "Hydr. chlor." has been chloride of mercury, and the only doubt would have been *which* chloride. But neither of these could be intended in this case, and we find the true interpretation in hydrate of chloral. The dose, the mode of administration, the association with tincture of henbane, and the fact that it is a night draught, all confirm this reading. But it will be necessary to remember in future, where we have not these clear indications from the context, that "Hydr. chlor." may be either calomel, corrosive sublimate, or hydrate of chloral.

LECTURE XXII.

PILLS—POWDERS.

Pills—Physical Requirements—Excipients for Rhubarb—Aloes—Creosote—Camphor—Essential Oil and Aqueous Extract—Hygroscopic Extracts—Copaiba—Sulphate of Iron—Oxide of Silver—Carbolic Acid—Cutting—Finishing—Coating—Silvering—Powders—Mixing—Dividing—Packing.

DISPENSING PILLS.

THE object of making any drug into pills is to have it in a form which is at once portable, permanent, and divided into convenient doses which are not nauseous to take.

The skill of the dispenser will be shown by the uniformity of his success in obtaining these results with the very various materials which he is expected to make into pills.

It is usual for the physician to prescribe the active conode of proceeding. No material is plastic without the resence of some fluid or semi-fluid body. But semi-fluids e of two distinct kinds, such as mucilage of acacia and ucilage of tragacanth; the former, even when it contains a ery large proportion of gum, will flow by its own weight; he latter, even when it contains a large proportion of water, ill not flow unless under some further mechanical force. ragacanth and water alone might be made into pills which ould not fall out of shape, but acacia and water would be anting unless some solid material were also present. If it ere required to impart adhesiveness to a powder such as inger, the acacia would be suitable; but if it were required o give firmness to a soft extract, such as acetic extract of olchicum, tragacanth would be more successful. If too much ragacanth be used, the mass will be *too* retentive of its shape, nd after having been rolled and cut, the pills will be found o retain a cylindrical form, which continues to return after hey have been repeatedly rounded; but if some fibrous aterial had been used, instead of part of the tragacanth, it ould have imparted that condition which enables any form o be given to the pills, and to be permanently retained by hem. As tragacanth is not readily soluble, it should only e used in small quantities unless in connection with hygrocopic or very soluble substances, otherwise the ready activity f the pill would be impaired. We may compare the pill ith the human body. A man could not stand upright if e had not a bony frame-work, nor could a skeleton stand ithout muscles and ligaments; in addition to these, the lood and juices of the body are required to impart that ondition which possesses at once firmness and the power of otion.

So in the structure of a good pill, we find the analogue each of these essentials to a perfect animal. A fibrous wder represents the bones of a pill, gum or extractive atter stands in the place of the muscular element, and the oisture, without which gum is not adhesive, represents the blood. By the junction of the three you may obtain a perfect pill, but any two separately will fail to produce the requisite qualities.

When any difficulty presents itself, a consideration of the nature of the materials in hand, and the requirements of a good pill mass, will generally enable the dispenser to select from the list of excipients appended to this lecture, some one, or some combination of two, which will give the requisite physical condition without much difficulty and without any injury to the therapeutical activity of the drugs.

I have now to direct your attention to prescriptions and samples of pills, illustrating deficiency of one or other of these elements, and to point out to you the appropriate excipients by which to supply the deficiency.

No. 1.

℞ Pulv. Rhei . . . . . ʒi.
ft. Pil. xx.

This may be combined with water, syrup, mucilage, treacle, glycerine, or solution of potash. Water makes a rather crumbly mass—solution of potash the toughest. But while we may be satisfied with the physical qualities ows no appearance of solution in ten times that period. In e course of three hours, the former pill will be completely sintegrated; the latter requires about double that time.

It is a great advantage to add precisely the right quantity f excipient at once. For 1 drachm of rhubarb powder, fluid drachm of water, syrup, or glycerine may be used. f only half the required quantity be added at first, a mass s formed which is too hard to be rolled out, and with which it is very difficult to mix an additional quantity of the excipient.

Aloes and gum-resins generally require much less excipient: thus— •

No. 2.

℞	Pulv. Rhei	
	„ Aloes.	āā ʒss.

ft. Pil. xx.

Is conveniently made with 20 minims of syrup instead of 30, which would have been used if the whole of the powder had been rhubarb.

If simple rhubarb pills are made up with water only in an iron mortar, the rhubarb is blackened by the mortar; but if syrup or some other excipients be used, the blackening does not take place. This is an example of the conservative power of sugar, which is often useful both in protecting iron compounds against oxidation, and preserving vegetable matters from the injuries they are liable to sustain by long keeping.

No. 4.

℞	Extr. Aloes Aq.	gr. xxxvj.
	Cons. Rosæ	gr. xviij.

M. ft. Pil. xii.

No. 5.

℞	Ext. Aloes Aq.	gr. xxxvi.
	P. Ligni	gr. vi.
	Glycerin	gtt. vi.

M. ft. Pil. xij.

No. 6.

℞	Extr. Aloes Aq.	gr. xxxvi.
	Sapo. Hisp. (Nov.)	gr. xij.

M. ft. Pil. xii.

I have experienced no difficulty with extract of aloes pills, since it became the custom to use the extract in powder. When the rule was to have the extract of a pilular consistence, the pills were with difficulty made to retain their shape.

The three preceding recipes show the comparative advantages of these excipients in forming aloes into pills. The conserve makes a good mass, which works well and does not get hard, but if not kept very dry the pills become soft and sticky, and perhaps run into a lump, at any rate do not retain their shape.

No. 5 remain soft and sticky, but do not lose their shape, and I do not know any fibrous material which will impart this retentiveness of shape to a soft pill with so small an increase of bulk as fine sifted sawdust. It may be considered "pure bone" to a pill, according to the analogy which I traced to you just now; and glycerine is the most perfect retainer of moisture, and consequently softness, which we can select; but being hygroscopic, the pills are apt to become too soft and sticky if not kept in a very dry place; we can easily reduce this tendency by diluting the glycerine with water or spirit, used in larger or smaller proportion as circumstances indicate.

nerally useful where it is desired to form into pills any ler which is bulky, amorphous, and not adhesive.

No. 8.

℞ Creasoti	gtt. xxiv.
ft. Pil. xii.	

h—

P. Amygdal.	gr. xxx.
Glycerin	gtt. xii.

rith—

Cera Flav.	
P. Saponis	āā gr. xii.

he first of these forms depends for its efficacy upon the ar of almond powder (in preference that deprived of its to facilitate a permanent union of oily and watery matters, thus prevent the creosote "sweating" out, but the pills ot readily dissolve. The latter form is preferable, as the converts the creosote into a jelly-like paste, and the soap les it to emulsify in the stomach.

No. 9.

℞ Camphoræ	gr. xxxvi.
ft. Pil. xviii.	

h—

P. Amygdal.	gr. xii.
Glycerin.	gtt. xv.

No. 10.

℞ Camphor.	ʒss.
Ol. Caryoph.	gtt. vi.
ft. Pil. xii.	

h—

P. Saponis	gr. vi.

No. 10 B.

℞ Camphor.	ʒi.
ft. Pil. xii.	

h—

Ol. Ricini	gtt. iv.
P. Sapo.	gr. ij.

No. 10 C.

℞ Camphor.	℈i
Extr. Hyoscyami	℈ii.
ft. Pil. xii.	

These formulæ illustrate several modes of giving camphor in pills. No. 9 is similar to the creosote pills just above; but as we are now dealing with a concrete oil, there is no need of a large bulk of absorbent material; the larger proportion of glycerine, and smaller quantity of almond meal, make a more soluble pill.

No. 10 gives us the task of combining both camphor and essential oil into a pill, which is simply done by the use of powdered soap, but would have presented considerable difficulty if the quantity of oil of cloves had been so great as to dissolve the camphor.

In 10 B we purposely added oil as an excipient, and it is about the best we can use to make 5 grains of camphor into a pill of no extraordinary size. The camphor must be *rubbed* to a powder with the oil, and then *worked* into a mass with the addition of the soap.

The pills Nos. 9, 10, and 10 B, being immersed in cold water, we find the first is readily disintegrated, the second requires several hours, and the third is but little acted upon. No doubt the warm reception they would meet with in the stomach would effect their dissolution in a much shorter time, but probably still in the same sequence.

No. 11.

℞	Extr. Coloc. Co.	℈ii.
	Pil. Rhei Co.	ʒi.
	P. Ipecac.	gr. x.
	Extr. Anthem. . . .	℈ii.
	Ol. Anthem.	gtt. x.
M.	ft. massa in pil. xl. div.	

(Exemplum 19,781.)

The oil being rubbed with 5 grains of powdered soap, l then the colocynth, rhubarb, and ipecacuanha added, med a good mass, which became crumbly immediately n adding the extract of chamomile. The addition of lrops of liquor of potash perfectly restored its plastic con-ion. A second box of the same was made as follows :—

The colocynth, rhubarb, ipecacuanha, and extract of momile were rubbed together, and then the oil, previously ced with 5 grains of powdered soap. The mass was in d condition till the oil and soap were added; it then ame very crumbly, which defect was in great measure nedied by adding 4 drops of spirit.

A third box of pills, made according to the same prescrip-n as last, but with almond meal instead of liquor of potash, rcame the crumbly nature of the mass.

The potash in the former case, and the emulsin of the nond in the latter, act the same part in the pill mass ich they do when used in the production of emulsions, ., effect the intimate and permanent mixture of oily and ueous materials. Regard must be had to the tendency hich almond meal has to impart hardness and insolubility the mass if employed in any large proportion. Liquor of tash, though a powerful chemical, is not so objectionable as ight at first sight appear, for in the quantity used it probably es little more than neutralize any acidity in the extracts.

No. 12.

℞	Pulv. Rhei	℈i.
	Pulv. Myrrhæ	gr. xv.
	Extr. Anthem.	
	„ Aloes Aquosi	āā ℈ss.
	Ol. Anthemidis	gtt. xvi
M.	et distribue in pilulas xx.	

(Exemplum).

The oil works out of the pills unless its retention is effected by the addition of liquor of potash, almond powder, or yellow wax.

A small quantity of wax used in formulæ of this kind readily emulsifies with the other ingredients of the pill, especially if soap also be present. The quantity used should be so proportioned as to impart a soft gelatinous condition to the oil before the other ingredients are added.

No. 13.

℞ Extr. Colchici Acet.
„ Coloc. Co.
„ Hyoscyami . . . . āā gr. xviii.
ft. Pil. xii.

These ingredients when mixed are too soft for convenience. They have been dried to give them a suitable firmness, and the pills kept in an ordinary pill box.

No. 14 are the same in every respect, but kept in a bottle.

No. 15 are the same, but with the addition of a small quantity of powdered tragacanth to give the desirable firmness.

No. 13 became soft by reabsorption of moisture, and fell out of shape; now, by long keeping, they are hard but misshapen. Nos. 14 and 15 have both retained their shape mp, and is now a soft extractive mass without any appear- ce of ever having been made into pills.

No. 18 have retained their shape satisfactorily, and are now ther hard, but are readily acted upon by water.

Tragacanth, if in too large proportion, gives the mass a tractile character, and the pills, after being rolled round, aw back into short cylinders, and are with difficulty made retain the spherical form; they also become very hard, dry, id less soluble than we could wish; but these objections ly apply to cases where it has been used with want of dgment; if used in moderate quantity, and in conjunction ith hygroscopic or readily soluble materials, it is a most luable excipient.

The condition of No. 17 should be a caution to you not to ust to drying hygroscopic extracts to a so-called "suitable nsistence."

The consistence which is really the most suitable for them possess is such as gives them the least disposition to change eir consistence by ordinary keeping. If they are then too ft, the requisite firmness is best given by their union with rmer drugs. You will remember in this connection the periments I showed you in my lecture on drying.

The next four prescriptions have been selected to illustrate ases in which the materials are too hygroscopic to be safely rusted without the addition of some such excipient as powdered tragacanth.

No. 18 A.

℞ Extr. Colchici Acet.
„ Hyoscyami . . . . āā gr. i.
Pil. Hydrarg. . . . . gr. ii.
M. ft. Pil.
(c̄. G. Tragacanth, gr. i.)

No. 18 B.

℞ Extr. Colchici Acet.
Pil. Hydrarg. . . . . āā gr. iv.
P. Ipecac. . . . . . gr. ss.
ft. Pil. ij.

No. 18 c.

℞ Extr. Colchici Acet.	gr. ss.
„ Conii	
„ Hyoscyami	āā gr. vi.

ft. Pil. iv.

No. 18 d.

℞ Pil. Hydrarg.	℈i.
P. Ipecac.	gr. vi.
Extr. Colchici Acet.	
„ Hyoscyami	āā gr. xii.

ft. Pil. xii.

No. 19.

℞ Ol. Lastreæ Filicis Maris . . .	gtt. xvi.
Sapo. Venet.	gr. viii.

P. Amyli q.s. ft. pilul. No. x.

Sumat pilul. mane.

In this instance (No. 19), well-judged excipients have been selected by the physician; the soap combines well with the liquid extract of male fern, and gives it a ready emulsibility, while the requisite firmness is imparted by the starch.

No. 20.

℞ Bals. Copaibæ	ʒvi.
Pulv. Cubebæ	℥i.
Ferri Carb.	ʒi.

ft. Electuar.

Sign—A teaspoonful night and morning.

n cold water without appreciable change, and even boiling n water and in strong hydrochloric acid had little effect pon them. But when about fifteen months old they disntegrated by a week's immersion in cold water; they were ot much affected by boiling for a few minutes in water, ut dissolved with effervescence in boiling hydrochloric acid. he magnesia having become carbonated by long keeping, o doubt facilitated the disintegration of the pill. In the ction of the acid this may perhaps be accounted for by the fferveseence acting mechanically in tearing the pill open. erhaps it would be better to use carbonate of magnesia nstead of calcined in such formulæ.

No. 21.

℞ Ferri Sulph.	. . . .	gr. i.
Pil. Rhei Co.	. . . .	gr. vii.

M. ft. Pil. ij.
Mitte xvi.

(Exemplum 22,183.)

The addition of sulphate of iron to a mass containing soap ives it a crumbly nature, which is very inconvenient in olling out.

The addition of caustic potash would remedy the physical efect, but at the sacrifice of chemical integrity, and our roblem is to find some material which facilitates emulsiction, or the union of oily and watery materials, without ecomposing sulphate of iron; almond meal is the substance hich naturally suggests itself, and with satisfactory results. he addition of 4 grains of almond meal and 8 drops f water reduces this refractory mass to a workable conition.

As a general rule, masses which threaten trouble from eir crumbly nature, may be worked if made a little softer an usual; and this expedient we are the more willing to lopt as the crumbly condition and the tendency to fall out shape do not commonly occur together.

Iodide of potassium, chloride of ammonium, and many other soluble crystalloids are difficult to render plastic with the usual aqueous excipients, but may be made into very good condition by means of some excipients of a resinous nature. Unguentum resinæ may be conveniently used for sulphate of iron, iodide of potassium, &c., and though it cannot claim to be an elegant excipient, it is not more objectionable than castor oil, which is official in Plummer's pill.

The insolubility in water may be raised as an objection t excipients of this class, but if they are no less fusible tha resin ointment, there need be little fear of the stomach bei incompetent to dispose of them as it does of other fat matters.

No. 22.

℞	Argent. Oxidi.	gr. iij.
	Extr. Belladon.	gr. ¼.
	Extr. Hæmatoxyli	gr. iss.

M. ft. Pil. quotidie ante prand. sumend.

Oxide of silver and red oxide of iron are apt to give trouble, especially in combination with astringent materials, such as extract of logwood or extract of hops. If the mass is made very soft and worked off rapidly, it may be divided without difficulty; but the pills may thus be inconveniently large, and become very hard by keeping. Castor oil and powdered soap worked into a soft pulp make a convenient excipient

No. 23.

℞ Acid Carbol.	gr. xxiv.
ft. Pil. xxiv.	
Aq.	gtt. j.
P. Saponis.	
Cera flav. in lamina	āā gr. xv.
P. Rad. Taraxaci	gr. xxiv.

The acid rubbed with the water became liquid; the soap and wax converted this into a soft emulsible paste, to which a suitable firmness was imparted by the use of the taraxacum powder. The spongy nature of taraxacum, and its freedom from active properties, make it very suitable as an absorbing material for soft masses.

No. 24.

℞ Acid Carbol.	gr. iij.

ft. Pil. i. Mitte xlviij.

The carbolic acid having been increased to 3 grains in a pill presented more difficulty, but the task was accomplished in the following way:—

Purest carbolic acid, 144 grains, and 24 grains of yellow wax, were melted together in a test tube, poured into a cold mortar, and rubbed into a rather adhesive powder; soft soap was then added by small degrees till 8 grains had been added, when it was found that the whole could be worked into a mass and divided into pills.

No. 25.

℞ Phosphori	gr. vi.
Micæ Panis	q.s.
ft. Pil. xxiv.	

Phosphorus is most readily and most perfectly divided by being dissolved in bisulphide of carbon and poured upon the pulverulent excipients; the solvent speedily evaporates, and the phosphorus is apt to take fire if not combined with a moist or plastic excipient at the right moment. Bread crumb is not the best material for giving substance in this case, but may be understood to mean any excipient the dispenser finds desirable. The best form for dispensing the above is to dissolve the phosphorus in a few minims of bisulphide of carbon in a test tube; while this is dissolving weigh out the following ingredients:—

P. Tragacanth	gr. xii.
Sapo Mollis . . .	gr. xxiv.
Pulv. Glycyrrhizæ,	
Conf. Rosæ	āā ʒss.

Put the tragacanth into the mortar, pour upon it the solution of phosphorus, rinse out the tube with a few drops more of sulphide of carbon, adding this to the tragacanth, and rub for a moment. The sulphide of carbon is almost instantly volatilized, and to prevent the phosphorus taking fire, the soap should be added as soon as the fuming becomes considerable; when this is mixed the liquorice and conserve may be worked in to give the required bulk and firmness. The sulphide of carbon is so readily and so completely volatilized as to leave no unpleasant odour. The only improvement I should suggest upon this formula is the addition of some essential oil. The vapours of essentials oils have a remarkable property of preventing the glowing of phosphorus in the air, and would prevent the danger of its taking fire at the moment when the solvent had evaporated; probably a little oil of cloves would also tend to preserve the phosphorus unoxidized in the pills.

other crystalloids. It is important to have ely powdered and thoroughly worked with the tion of the excipient that will suffice, say, 4 or plenty of working and a little heat. When nay be silvered or dusted with French chalk, hed, as the resinous matters make the pill of hardening on its surface. They are best bottle. Chloral may also be worked into a any addition but camphor, of which a very r suffices—about ½ grain for 1 drachm. In oportion it may probably be regarded as an e excipient; an excess would reduce the chloral id or fluid state, and necessitate the addition of lers.

few chemicals occasionally prescribed in pills, re or less subject to decomposition by contact matters; the silver salts may be taken as ples, and permanganate of potash as an ex- this kind. The latter body is best made up y and water.

No. 27.

sæ Permangan. . . . gr. xxiv.
i.

lay in powder, 36 grains; water, 18 drops. A nass is thus obtained, which keeps its phy- ical condition satisfactorily and disintegrates ater, yielding the permanganate unchanged.

s having been formed by suitable excipients, olled and cut. Some masses, such as contain and essential oil, or soluble crystalloids, are mble under the roller. When this is the case better rolled under the hand, the yielding skin helping to keep the mass together; they probably crumble in cutting, and if this be is better not to roll them under the cutter, divide them with pressure between the two cutting surfaces, and round them by rolling between the fingers and thumbs. A dexterous operator will roll four at a time, taking two between the fingers and thumb of each hand, and will keep the others in a plastic condition while he is doing it by holding them in the palms of his hands with the two outer fingers.

Masses which are in good condition may be rolled into pills almost perfectly round and smooth if the machine be selected of a suitable size. Imperfectly formed pills may be finished by rolling them under a pill finisher, which is a circular piece of wood with a rim similar in shape to the lid of a turned wood box. The pills, being placed upon a slab and covered with the finisher, are to be rolled with a light pressure in what may be called a double circular direction, which we may compare to the path of the moon moving in small circles round the earth, and in large ones round the sun at the same time.

It is not generally desirable to send out pills without some description of covering; liquorice powder and magnesia used to be the materials chiefly employed for this purpose, but are objectionable on account of their stickiness; too much adheres to the pill, and is unpleasant in the mouth.

r become so sticky that they will not roll side by upon the paper, but roll over one another, and would, ie rolling were continued, stick into a mass; when in this dition throw them into the pot upon the silver, put on cover, and shake violently. They will then be found ered pretty perfectly with the leaf, and any loose particles r be blown away.

f these instructions be not exactly followed, the coating ikely to be imperfect; and if once imperfectly coated, it lmost impossible to make any better of it without comncing *de novo*, using a very stiff mucilage, or mucilage l powdered gum alternately, till the pills are *very* sticky, l then shaking them with a fresh leaf of silver.

Various other methods of coating pills have been introed within a few years. I can only allude to one, which I say from constant use answers perfectly and without any uble or difficulty.

A tincture of sandarach is made by dissolving 1 oz. of the m in 3 oz. of ether. A few drops of this are put into a ered pot, the pills thrown in, instantly shaken, and turned t upon a tray to dry for a minute, and are then ready for e box.

Pills coated in this way may be kept in the mouth for a inute without being tasted, but the coating yields to the tion of moisture in a few minutes, and the coating with ver leaf yields even more readily; there is consequently fear of a pill losing activity from either of these coatings, ovided the solubility of the pill itself is satisfactory.

Powders.

The dispensing of powders is a very simple operation, and uires but little comment.

f a single powder of one ingredient is ordered, there is hing to be done but to weigh it, fold it in paper, and te the appropriate directions.

f it contain two ingredients, for appearances' sake they should be mixed to look uniform, a rubbing with the knife upon the paper being sufficient for that purpose.

If there are several powders of mixed composition, the ingredients should be rubbed together in a mortar; a thorough union is much more readily obtained by its use, and it is not a matter of indifference in what order the ingredients are put into the mortar. Thus, in the following :—

℞	Calomel	gr. xij.
	P. Sacchari	ʒj.
ft. Pulv. xij.		

Do not put them in in the order in which they are written. Put the sugar in first and the calomel upon the top of it; the mixture will sooner be uniform, and less calomel will adhere to the mortar.

℞	Bismuth Tris. Nitr.	ʒij.
	Magnes. Carb.	ʒj.
	P. Sacchar.	ʒj.
	Ol. Caryophyli	♏ xij.
M.	Ft. pulv. xij.	

Put the sugar in first, drop the oil upon it, and rub them together ; then add the magnesia, and lastly the bismuth, Though some people can acquire a great degree of accuracy and dexterity in thus dividing the doses, it is not desirable to trust to it. The habit of weighing is most commendable, not only because of its insuring accuracy in the division, but, if a patient fancies that the powders act more at one time than another, it is a great satisfaction to both dispenser and patient to know that each one was accurately weighed; and the weighing out of twelve powders of 1 scruple each, when the whole bulk weighs 4 drachms, is a good practical lesson in accuracy and a useful check upon the correctness of the first weighing—the omission of an ingredient or the doubling of a quantity is thus guarded against.

If a powder is prescribed in bulk it should be sent out in a bottle, unless there be instructions to the contrary.

Volatile powders, such as carbonate of ammonia, sometimes prescribed in effervescing draughts, &c., should be enclosed in a wide-mouthed bottle, whether they are sent out divided or in bulk.

Deliquescent powders may be dispensed in the same way, but it is desirable in this latter case to use the additional precaution of folding them in waxed papers.

Questions for Examination.

What is the object of making medicine into pills?

What is the characteristic difference between the mucilages of tragacanth and acacia as excipients?

In what cases should tragacanth be used, and in what quantity?

What are the mechanical elements of a good pill mass?

In what respects do sugar and glycerine compare and ontrast as excipients?

What objection is there to the use of pure glycerine as an xcipient?

What excipients are suitable for making oily material into pills, either alone or in combination with watery extracts?

What consistence is the most suitable for any giv extract?

What objection is there to reducing hygroscopic pills to suitable consistence by drying?

What species of excipient is most convenient for giving suitable consistence to crystalloids soluble in water?

RECAPITULATION.

The object of forming a drug into pills is to have it in convenient doses, easily taken, and not liable to change by keeping.

The physical qualities of a good pill mass are such as permit of its being readily formed into shape without crumbling, or subsequently falling out of shape or losing solubility.

These qualities are usually best attained by the presence of a fibrous material, a mucilaginous element, and water.

ls soluble in water, and some other materials not l with aqueous excipients, are more tractable in with oily and resinous materials.

TABLE OF PILL EXCIPIENTS.

r vegetable powders containing fibrous and matters.

vegetable powders containing fibrous and ters.

f acacia or syrup, for fibrous vegetable powders ly mucilaginous.

f tragacanth and glycerine, for powders deficient us and mucilaginous characters.

ax, for essential oils, creosote, carbolic acid, &c.

re (blotting paper pulped), for giving firmness to fall.

tragacanth, for giving firmness to hygroscopic

for giving permanent softness and solubility to s powders.

soap, to aid the blending of oils or resins with cts.

owder, to effect the same object in the presence of iron or other matter incompatible with

x, and oil, for uniting crystalloids soluble in

and soap, for combining vegetable astringents of iron, silver, &c.

of magnesia, for giving firmness to balsam of assafœtida, galbanum, &c., in the presence of

y, for chemicals liable to be changed by contact matter.

LECTURE XXIII.

OINTMENTS, PLASTERS, SUPPOSITORIES, ETC.

Dispensing Ointments, Plasters, Suppositories, &c.—Ointments, Gritty Materials, Extracts, Watery Materials—Plasters, Spreading, Shapes, Adhesive Margins, Blisters, Prescriptions—Suppositories, &c., Cacao Butter, Lubricants for Mould, Tin Foil Moulds.

THE dispensing of ointments is one of the very simple operations of pharmacy; it rarely involves the melting of the ingredients, usually only the mixing of two or more materials together, one of them at least being unctuous, and the chief aim is to insure perfect smoothness and uniformity. Dry materials should be reduced to the finest possible powder, if not dissolved before being added to the grease. Watery extracts, where such are prescribed, should be reduced with water, glycerine, or spirit, to a consistence at least as soft as the grease with which they are to unite.* Chemicals should be protected against the chance of decomposition, which might in some cases take place from contact with steel knives or marble slabs or mortars.

ming soiled in carriage ; but if the ointment is firm, the f paper is better avoided, as it becomes disagreeable itself ft there, and answers no useful purpose.

will illustrate with a few prescriptions selected from al practice :—

℞	Hydrarg. precip. rub.	ʒiij.
	Cerat. cetacei	℥j.
Ft. ung.		
℞	P. boracis	ʒij.
	Ung. cetacei	℥ij.
Ft. ung.		
℞	Potassii iodidi	℈ij.
	Adipis	℥ij.
M.		

the first of these the powder must be rubbed as fine as ible in the dry state ;* it may then be transferred to a to be mixed with the ointment, or the ointment may be d in the mortar. It is scarcely possible to make the der as smooth by rubbing on a slab with the grease, but ay be made smooth by grinding with a small portion he grease in the mortar, though in some cases this is ely practicable. The borax may be obtained fine by g effloresced, and the red oxide of mercury by being ipitated in the wet way ; but these are scarcely legitimate ations from the customary practice, unless the sanction of prescriber can be obtained. Borax may also be made a smooth ointment by dissolving it in glycerine.

n the third example the iodide is equally difficult to rub oth, unless with the addition of a little water, which may onsidered admissible, as it is adopted in the official oint-t of iodide of potassium.

℞	Ung. hydrarg.	
	Extr. belladon.	āā ʒss.
M.	ft. ung.	
℞	Extr. belladon.	ʒjss.
	Acid. hydrocyan. Sch.	ʒss.
	Adipis	℥j.
M.	Ft. ung.	

Unless kept ready for use by moist grinding and subsequent drying, as ribed in my lecture on grinding.

The extract of belladonna of commerce is usually soft, but if it be of anything approaching a good pilular consistence, it must be diluted with glycerine till at least as soft as lard; it will then pretty readily mix with a knife and slab. In the second ointment the softened extract and lard should be mixed first, and the acid added by drops while the ointment is being rubbed on the slab, so as not to allow the acid to be long exposed to the action of the air. The greater stability of hydrocyanic acid in the presence of glycerine should be borne in mind in cases of this kind, and is a further reason for the use of the latter in softening the extract. When once thoroughly mixed with the grease, it is much protected from evaporation. Probably an alkaline cyanide, instead of hydrocyanic acid, would be a change for the better.

℞	Liq. plumbi,	
	Glycerin	āā ʒij.
	Ceræ. alb.	ʒiv.
	Atropin.	gr. iv.
M.	Ft. ung.	

In this case, it being found quite impracticable to mix white wax into an ointment with these ingredients, it was supposed that ceræ. had been intended for ceratum, which was consequently used, and a satisfactory ointment

The oil and oxide being mixed together, the watery liquids fused to unite with them.

The watery liquids being mixed with the oxide, and the oil irred in, at first all blended, but the liquors afterwards parated again.

It thus became necessary to add some excipient capable of mulsifying the whole. Soap would, no doubt, have effected his object, but with the decomposition of the hydrochlorate f morphia, as this was not admissible, we had recourse to the ollowing method with perfectly satisfactory results:—

Take a Jordan almond, and having scraped the brown skin ff, reduce it to powder and rub it with the oxide of zinc and he liquors till quite smooth, then add the oil, rubbing with a nife upon an ointment slab, till the whole forms a smooth nd uniform ointment.

Almond powder (free from the skin) would no doubt be qually efficacious in mixing other aqueous fluids with oil or intments.

PLASTERS.

The spreading of plasters is an art of which little can be earned by verbal instruction. Practical demonstration on he part of the teacher, and practical experience on the part f the learner, are the only means by which the art of spreading plasters with facility can be acquired.

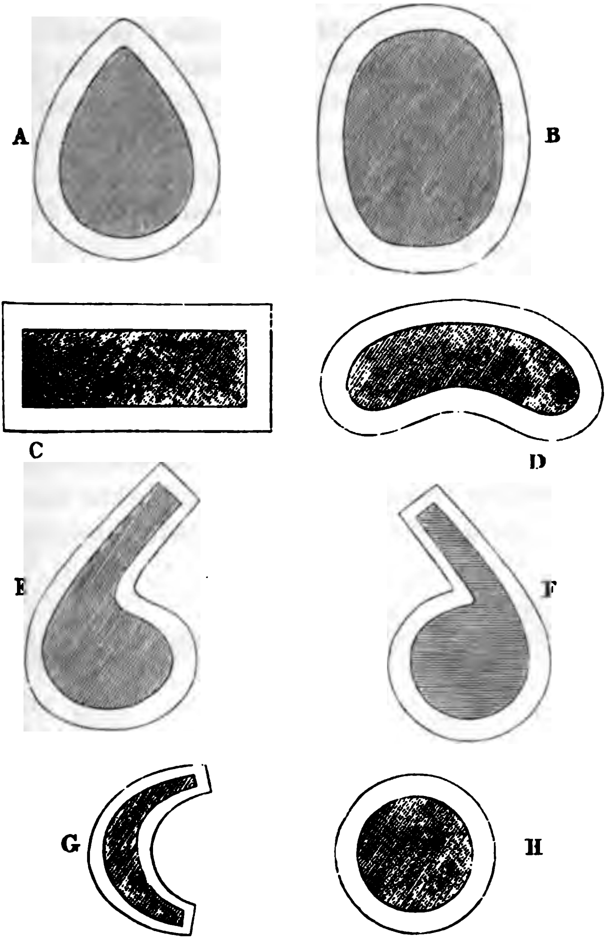
I will first draw your attention to a few points, and then roceed to give practical demonstration.

Plasters are spread upon paper, textile fabrics, or leather; n dispensing, the latter is almost exclusively used. The ode of spreading surgeons' strapping, ordinary adhesive laster on calico, is not of sufficient importance to the retail harmacist to warrant our spending time over it; we will herefore confine our attention to the spreading on leather. The leather used is known in commerce as sheep skin, split kin, lamb skin, and kid skin; the first being employed on all rdinary occasions, the others being used where thin and soft plasters are specially required. In selecting a piece of leather it should be taken from a part of the skin which will enable it to be cut of pretty uniform thickness and *flat*. The edges of the skin are generally stretched, and though they may be used with a little extra care and skill, they are apt to draw back more or less to the shape they originally possessed upon the living animal. Split skin is frequently used where a plaster is required as a protection to a bed sore, and for this purpose the plaster is usually spread close to the edge of the leather, as a loose margin is liable to become folded under the patient, much to his annoyance; this necessitates the spreading of the plaster as thin as possible to avoid its melting with the heat of the body, and running out beyond the leather and soiling the clothes.

The leather having been selected and cut, is to be laid upon a quire of brown paper, which forms a bed of a convenient degree of softness, and which does not abstract the heat of the plaster too rapidly. The leather should then be smoothed with a gently heated spatula, the requisite degree of heat being judged by its just sufficing to throw off a drop of water in the spheroidal state, or by the sensation of warmth it produces when held near the face. The inexperienced the supply of gas always attached to the handle. Taken gether, I find the simple iron generally preferred.

he shapes of plasters are determined by the part of the y to which they have to be applied, the following (Fig. , being the usual :—

Fig. 36.



A, for the chest, heart-shape. B, for the shoulders, oval. C, for the ll of the back, oblong. D, side, kidney-shape. H, knee, round. Ears, ort shape or crescent. F, right. E, left. G, either.

The plaster is melted by rubbing it againt the hot spatula held upright with the tip resting upon a piece of paper; when sufficient is melted, it is pushed off the paper upon the leather which is to receive it, and the spreading effected without loss of time by pushing the melted plaster over the leather, the latter being turned about in such a way that the melted material may be pushed *from* the operator. The position of the spatula should be such that it presses upon the leather by the edge nearest the operator, and the pressure should be lighter in proportion as the plaster is more fluid.

Patterns of stiff paper or card may be kept to aid in drawing any of these shapes upon the leather previous to cutting.

In the spreading of plasters, neatness is much facilitated by the use of what is technically called a plaster-shape, or mould of paper, which consists of a sheet of paper with a piece cut out of the centre the size and shape which the plaster is required to possess.

All the forms given above, except those for the ears, ar symmetrical, and may be cut equal-sided by doubling a she of paper, and making the fold represent the symmetrical a and then cutting both sides at once along the line that rep sents the edge of the plaster. For the heart shape, the sh e during the smoothing of the leather, and to allow also rimming the edges when the plaster is finished.

aving cut and smoothed the leather, lay upon it the e of paper cut from out of the marginal shape in exactly place which is to be covered with the adhesive material, , having dipped the marginal part in water, lay it carey round the centre piece without disturbing the position he latter, then apply a little pressure, and the moist paper adhere to the leather. The centre piece being removed, plaster is to be spread in the manner before described, , as the operator's attention is not needed to keep it to the ired shape, the process is easily and quickly performed, whole attention being given to making it smooth and of form thickness. As soon as this is done, the paper margin o be lifted at one edge and pulled off while the plaster is l warm. The trimming of the edge of the leather then pletes the operation.

When a plaster, the material of which is deficient in esiveness, is to be spread upon leather with an adhesive rgin, such as in the prescription (Fig. 41) following, the ration may conveniently be performed as follows :—

irst cut the paper shape with the centre piece the size the lock has to extend, and proceed to spread the plaster in manner already described; when this is finished and firm ugh for convenient handling, the adhesive margin may be ed by covering up the hemlock plaster with paper, and ching to the leather a new paper margin as much larger n the first as to leave the leather uncovered to the width half an inch or more round the hemlock plaster; it will n be ready to receive the resin plaster, which may be spread n the marginal space with little difficulty. The only nt likely to give trouble is the sticking of the paper cover he hemlock plaster, which it will be very apt to do if it covered with a simple dry paper and the hot iron or ted resin plaster should run a little over its surface. This uble will be avoided if the paper cover have a temporary adhesiveness imparted to it by smearing it with fine soft soap, or the glycerine and tragacanth mucilage used for making pills. In this case, when the margin is finished and the central covering paper removed, the face of the plaster will require cleansing with a wet cloth or sponge.

Sometimes plasters requiring an adhesive margin are simply spread upon a piece of adhesive plaster on calico. This is the usual custom with blisters, the paper shape being used as before, but the plaster, instead of being melted and spread with the spatula, is spread with the thumb, no more heat being employed than it gets from the hand. In cold weather cantharides plaster becomes crumbly, but its plasticity may be restored by working it in the hand for a minute before using the thumb as a spatula, or by beating it with a gently warmed iron. It may of course be spread with the iron in the usual way, if the iron be so gently heated as to impart softness but not fluidity to the material, a sufficiency of the cantharides plaster being reduced to a soft plastic condition by beating it with the warm iron on a piece of paper before commencing to spread. When the spreading is finished, the surface may be smoothed with a warm knife or plaster iron, and a little dry cantharides powder rubbed in before removing the paper margin.

When compound plasters are prescribed the ingredients

No. 2.

℞	Extr. belladon.	gr. xij.
	Mellis	ʒss.
	Empl. belladon.	ʒiiss.

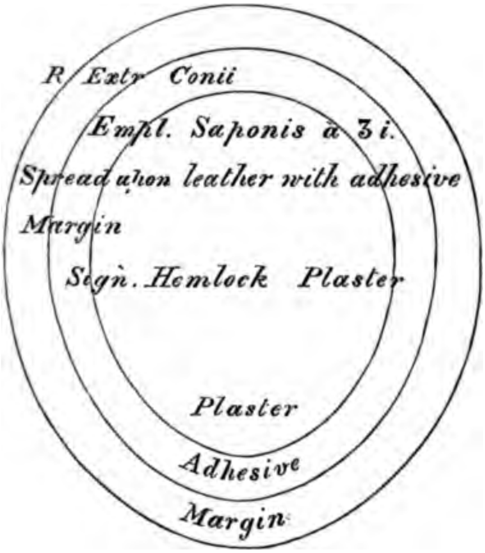
M. Extende super alutam.

1. The belladonna and pitch plasters being melted tin plate, the camphor was stirred in with as little possible.

fourth of the quantity of material was sufficient. It stated, as a general rule, that one drachm of material ient for ten square inches of surface.

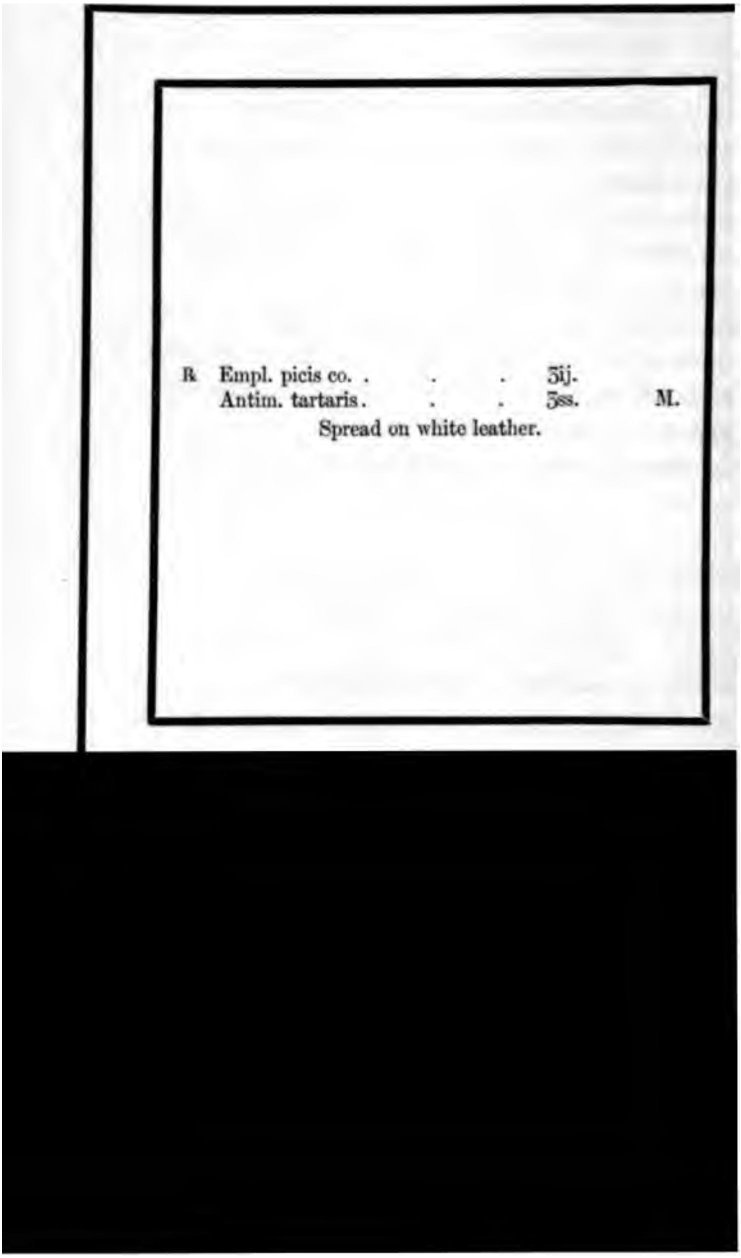
2. The extract and honey were mixed upon a tin plate ns of the spatula, and then the plaster added and all together. This union of watery and resinous constiis not desirable, as it destroys the adhesiveness. same objection also applies to the next, Fig. 41.

Fig. 41.



ig. 42 (p. 322), the point requiring attention is to have ar emetic in the finest possible state of division, and hly mixed with the pitch plaster before it is spread.

Fig. 42.



℞ Empl. picis co. . . . ℥ij.
Antim. tartaris. . . ʒss. M.
Spread on white leather.

bowel, they sometimes left a residue which was objectionable, s not being readily removed. Cacao butter has now almost entirely superseded these mucilaginous excipients, though it s desirable to substitute a compound of gelatine and glycerine in some cases.

For this purpose 1 oz. of gelatine with 1 oz. of water and 3 fl. oz. of glycerine will afford a material of about suitable consistence. It is, of course, not a desirable basis for tannin suppositories. The mould may be lubricated with oil, and the melted materials should be poured in when only sufficiently warm to retain their fluidity. With this note in passing I must now go on to cacao butter, which may always be assumed to be the basis intended unless otherwise specified.

Powdered materials, such as opium, oxide of zinc, or tannin, should be rubbed smooth with a small quantity of oil of lard upon an ointment slab, while the cacao butter is being melted, with the addition of about one-sixth of its weight of wax or spermaceti, in a small water bath. When the grease is melted it should be allowed to cool again so far as to become slightly opaque before the other materials are added; they may then be stirred in with a teaspoon, and when mixed, and so far cool as to be of the consistence of thin cream, may be poured into the moulds by teaspoonfuls, stirring between each to insure the uniform distribution of the active matters.

Many dispensers have experienced difficulty in detaching he suppositories from the mould, as they are apt to adhere nd are broken in the attempt to extract them. They are usually cast in metal moulds made in two pieces, the conical ollows occupying the junction, so that, when the pieces are parated, the extraction of the suppositories is facilitated, nd may usually be effected without much difficulty if the ollowing conditions be complied with, *i.e.*:—The mould should e well shaped and well polished; it should be very cold hen the melted grease is poured in, and allowed to become quite cold again before it is separated; and the ma should not be too warm when poured in, and it should a sufficiently firm consistence when cold. As some of conditions depend upon the season of the year, &c., th penser cannot always command the means of certain s without some little variation in the mode of working. suggestions have been made to obviate this difficulty simplest and most obvious is to rub the mould over with and water, or glycerine (not oil), or water. To prev watery extract adhering you would naturally use oil; prevent a greasy material adhering, watery lubricant best. Water itself would answer perfectly if it could be to cover the surface of the mould without running drops; and this may in some measure be accomplished, mould be clean and cold, by breathing upon it, bl through an india-rubber tube into each hollow just pouring in the grease; but success is more certain wit use of a small portion of soap and water. Another m I have used is to make moulds of tinfoil, into whic suppositories may be cast, and as soon as solid they m immersed in a stream of cold water till hard; the foil then be unrolled without difficulty or any risk of the su

Pessaries and bougies, differing from suppositories only in size and form, may be made upon precisely similar principles.

Suppositories are usually made to weigh about 15 grains each, and of a rounded conical form, the outline being represented by two convex curves. Pessaries are of the same shape, but generally weigh 2 drachms each. Bougies are cylindrical, about 2½ inches long, 0·2 inch in diameter, and weigh about half a drachm.

LECTURE XXIV.

QUALITATIVE TESTS OF THE PHARMACOPŒIA.

THE system of testing adopted in the Pharmacopœia has three distinct objects in view—the first, to ascertain that the material under examination is really that which it is expected to be; the second, to prove the absence or the presence of impurities which the substance in question is liable to contain: and the third, to determine that the correct quantity of the most important constituent is present. The instructions generally are such that these objects are satisfactorily accomplished even by an operator who imperfectly understands what he is doing, provided he yields implicit obedience to the instructions given. But however carefully they may be drawn up and followed, no one could expect that his testing would be considered satisfactory either by his customer, his not attempt to go through all the materials to be r all the test solutions, nor yet all the tests which in those cases which I select for illustration, but pick and choose among the mass such as best serve se, which is to sketch out the manner in which you udy the paragraphs on "Characters and Tests," to the chemicals in the Pharmacopœia, to illustrate reaction in a few cases, and to throw a little light unexplained object sought in a few others.*

Acetum.

st chemical in the Pharmacopœia is vinegar, and it fair illustration of the diversity of methods of on, and the many little points which should claim ion in critically examining the common articles of . After noticing its brown colour and characteristic h which the pharmacist is expected to be familiar, formed that its specific gravity is 1·017 to 1·019. sities do not indicate any precise strengths, because ot purely the result of the acid it contains. It is ntain some fixed matter in solution which will add sity, and is very likely to contain some spirit which ct from it. The examination of its specific gravity e a test to which it is not frequently subjected; its eing much more accurately determined by its power izing a given quantity of caustic soda, which is the rought under our notice. A fluid ounce of vinegar uire 402 grain-measures of the volumetric solution r its neutralization, in which case it will contain nt. of anhydrous acetic acid.

ng vinegar with chloride of barium, a precipitate is rmed from the presence of sulphuric acid ; but as a entage of sulphuric acid is not objectionable, pro-

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lers, while they have one eye upon these pages, should have the e Pharmacopœia, otherwise they will be taking an antidote poison, a thing not often desirable.

vision is made that a fluid ounce of vinegar, after having been mixed with 10 minims of solution of chloride of barium of the British Pharmacopœia (1 in 10), and filtered from any sulphate of baryta which may have precipitated, shall not give a further precipitate with more of the chloride, proving that all the SO_3 in the ounce of vinegar had been precipitated by 1 grain of chloride; consequently that there was not more than 0·4 grain sulphuric anhydride in the ounce.

The absence of coloration, by the action of sulphuretted hydrogen, indicates its freedom from a considerable group of metals, copper and lead being the most likely metals of this group to be present. Iron, which is an equally probable impurity, is not indicated by sulphuretted hydrogen unless the acid be neutralized.

You will perceive that to go through the tests of the Pharmacopœia in this way would be much too lengthy a task for an evening's lecture; but it is what every pharmaceutical student should do in the regular course of his study. The limited number of reactions upon which it is practicable for me to make any comment necessitates my confining my selection to a few only of those which either illustrate a widely applicable test, or are not sufficiently clear to insure their and sometimes even distilled water itself, will give precipitates with BaCl or $AgNO_6$.

Acetic acid is also to be tested by mixing with pure hydrochloric acid and granulated zinc, and examining the evolved hydrogen for HS, which it would contain if the acetic acid contained sulphurous acid.

Glacial acetic acid is required to solidify at 34° Fahr., and not to melt again under 48° Fahr. The commercial acids frequently have higher freezing and melting points, indicating consequently greater strength.

Acidum Arseniosum.

Arsenious acid, if pure, is entirely volatile. Complete volatilization is used as a test in various other cases, such as the mercurial salts, ammoniacal salts, except phosphate (and some others which are not medicinal), also for iodine, benzoic acid, &c. But as entire volatilization does not prove the absence of other volatile substances, the test is supplemented with others. In the case of arsenious acid, with a volumetrical examination with iodine; in the case of benzoic acid, with the examination of its melting (248° Fahr.) and boiling points (462° Fahr.).

Acidum Citricum.

Citric acid is examined for tartaric acid, its most probable impurity, by the addition of a solution of acetate of potash, which yields a precipitate of cream of tartar if tartaric acid be present.

This method of detecting a suspected or probable impurity by the addition of a substance with which it forms a precipitate, if present, is one of the most generally applicable modes of testing. It must not be overlooked that citric acid produces a precipitate of cream of tartar if added to a solution of Rochelle salt or soluble tartrate of potash, as will sometimes occur in dispensing.

Acidum Gallicum.

This is examined for tannic acid, which, on the addition of a solution of gelatine, produces a leathery precipitate with the latter acid, but none with the former.

Acidum Hydrochloricum.

It is essential to dilute it with water before using BaCl as a test for SO_3, the chloride of barium being precipitated by the pure acid in a concentrated state. Sulphuretted hydrogen is used as a test for various metals with which it is apt to be contaminated, more especially iron and arsenic, the former of which will give a black precipitate if the acid be neutralized with ammonia after the use of HS. Arsenic yields a yellow precipitate in a dilute acid solution, but not in an alkaline. Boiling a piece of bright copper with the dilute acid is a further test for arsenic, which, if present, is deposited as a steel-grey film upon the copper. Sulphurous acid is tested for in the same way as was pointed out in connection with acetic acid. It is an impurity which by other modes of testing is easily overlooked.

Acidum Hydrocyanicum Dilutum

Acidum Sulphurosum

tested for sulphuric acid, which it always acquires by slow idation if long kept. Chloride of barium gives no pre-pitate unless sulphuric acid be present; but if chlorine be ded also, the sulphurous is converted into *sulphuric* acid, d the precipitate is immediate and abundant.

We may test sulphurous acid with permanganate of potash indicate its strength, thus—1 fl. oz. should entirely deco-rize 33 grains of permanganate, but should be pink on addition of 1 grain more.

This system of indicating strength or purity within definite nits is in some cases more suitable for pharmaceutical use, an a more strictly accurate testing which is essential for alytical or scientific purposes.

I have found commercial sulphurous acid contain sulphate lime as a crystalline deposit, the acid having no doubt en prepared by some other process than that of the British armacopœia.

Amylum.

In relation to starch, I need only point out that the testing th cold water and iodine, which is intended to indicate anules injured by heat or otherwise, may give the blue lour by over-powerful friction, even if the starch be perfect the first instance, as I pointed out in my lecture on inding.

Bismuthi Carbonas.

The presence of subnitrate is tested for with the sulphate indigo, which is bleached by nitric acid, but not affected pure carbonate of bismuth and pure sulphuric acid.

Calcii Chloridum.

Chloride of calcium prepared by the Pharmacopœia process y contain either chlorinated lime or perchloride of iron. e former is detected by addition of HCl producing the ur of Cl; the latter by a brown precipitate being deposited the addition of lime water.

Calcis Phosphas.

The testing of phosphate of lime in solution in nitric acid with acetate of soda, is intended to detect the presence of phosphate of iron, which is equally soluble in the nitric acid; but when the nitric acid is converted into nitrate of soda, and acetic acid left free, the phosphate of lime remains dissolved in the acetic acid, while the phosphate of iron is precipitated.

Ferri et Quinæ Citras.

The white precipitate which takes place in a solution of this salt when ammonia is added is quinine, the oxide of iron remaining in solution; but when caustic soda is added, a brown precipitate takes place, because peroxide of iron is precipitated along with the quinine. The testing of this salt is chiefly intended to ascertain the proportion of quinine present. Double citrates of iron and quinine having been in current use before an official strength had been established, and it was to be expected that pharmacists would continue for some time to meet with various strengths under the official name, it was important that a ready means of estimating the quinine should be indicated. The official mode of testing aimed at readiness rather than great accuracy, as under the

Ferri Peroxidum Hydratum.

The absence of a blue precipitate with red prussiate of potash indicates the absence of protoxide of iron as an impurity in the peroxide. The hydrated oxide should dissolve freely in acid; the anhydrous oxide is much less freely soluble, especially if a strong heat has been used in its preparation.

Ferri Sulphas.

Sulphate of iron, if entirely free from peroxide, gives a very pale blue precipitate with yellow prussiate of potash; the object of the test being to indicate by the paleness of the colour the comparative freedom from oxidation.

Liquor Bismuthi et Ammoniæ Citratis.

Solution of potassa and hydrochloric acid both produce white precipitates in solution of citrate of bismuth and ammonia; the former being a hydrated oxide of bismuth, the latter is citrate of bismuth, which, though soluble in citrate of ammonia, is not soluble in solution of chloride of ammonium or free citric acid.

Potassæ Citras.

The absence of an immediate precipitate when chloride of calcium is added to citrate of potash, indicates the absence of tartaric acid; but when the solution is boiled precipitation takes place, because the citrate of lime is less soluble in hot water than in cold. The citrate of lime once deposited, is only slowly taken up again as the liquor cools; probably combination with water taking place at the same time.

Potassii Bromidum

Is tested with mucilage of starch and chlorine to prove the absence of iodine, which, though much the more costly element of the two, is sometimes present as an accidental impurity.

Potassii Iodidum

Is tested with mucilage of starch and tartaric acid, which will give a blue precipitate if iodate exist in the iodide, but not otherwise.

Sodæ Bicarbonas.

Bicarbonate of soda is tested with perchloride of platinum to prove the absence of potash and ammonia, impurities which it is not liable to contain under ordinary circumstances. With perchloride of mercury, a white precipitate indicates that the soda is saturated with carbonic acid, while a brown precipitate indicates that the proportion of carbonic acid to soda is less than two equivalents to one.

Zinci Sulphas.

Sulphate of zinc yields a white precipitate with ammonia, soluble in excess of the reagent; and this reaction takes place equally well without the solution being first boiled with nitric acid, as directed in the Pharmacopœia, the object of this injunction being to insure the peroxidation of any iron present. The protoxide is not so perfectly precipitated by ammonia, and a small quantity might be overlooked, which would not escape detection if first peroxidized.

LECTURE XXV.

ITATIVE TESTING OF THE PHARMACOPŒIA.

testing is designed to determine the presence
that ought to exist in the material under
and the absence of everything else.
e testing is designed to determine the quantity
nt known to be present in the substance under

e examinations are either gravimetric, in which
is estimated by weighing, or volumetric, in
ntity is estimated by measuring the volume of
uired to produce a given change, the weight
rds ascertained by calculation.
tric analysis the constituent to be estimated is
ed and weighed in the separate state, or is
some new state of combination, the new com-
easily separated from the other constituents of
aterial, and the quantity of the element sought
from the proportion in which it is known to
ew compound formed.
onsider one or two gravimetric examinations
on to volumetric analysis.

Ferri et Ammoniæ Citras.

of this salt is one of the simplest possible cases
e examination.
sed to a full red heat, till it ceases to change in
sidue should weigh 27 per cent. of the original

salt, the loss being water, ammonia, and citric acid, and the residue peroxide of iron. The only source of error in the operation being the chance of small portions being carried off in scintillations, or part of the oxide being reduced to the state of protoxide, by the action of the organic matter present; but, if the heat be continued, any protoxide at first formed again absorbs oxygen, and becomes peroxide. It is necessary to supplement this test by ascertaining that the oxide of iron has not an alkaline reaction, which it would have if citrate of potash or soda were present in the original salt—organic salts of the fixed alkalies being converted into carbonate by incineration.

Acidum Phosphoricum Dilutum.

To estimate the strength of this solution, 6 fluid drachms (the British Pharmacopœia says 355 grains, which is the weight of 6 fluid drachms) is poured upon 180 grains of oxide of lead in powder, the whole evaporated to dryness, and calcined. The oxide of lead fixes the phosphoric acid, but allows the water to evaporate, so that the weight of the two, after calcination, is the weight of the oxide of lead (180) plus the weight of anhydrous phosphoric acid present in the 6 fluid drachms of dilute liquor. For this test to be available tion. This is accomplished by acting upon it with an excess of iodine dissolved in water with the aid of iodide of potassium. The iron, which has been reduced to the metallic state, forms a soluble iodide, but the oxide remains insoluble, and, after being washed, dried, and ignited, should not weigh more than half as much as the original sample of reduced iron. It is quite practicable to obtain reduced iron with much less contaminating oxide than here allowed, but it must be remembered that one object of having iron in this fine state of division is to insure its ready oxidation, and, if it be reduced at a low temperature, it is impossible to keep it from absorbing oxygen, which may even be so rapid as to cause its ignition.

Reduced iron might also be tested by acting upon it with a given weight of pure iodine so adjusted that there would remain a portion of iodine not combined with iron if the sample under examination contained the required proportion of metallic iron. This method of testing would have the advantage of giving the required information without the necessity of washing, drying, and igniting the insoluble residue.

Liquor Antimonii Chloridi.

Sulphide of antimony, treated with *strong* hydrochloric acid, evolves sulphuretted hydrogen, and becomes chloride of antimony; but in a feeble acid liquor, chloride of antimony, treated with sulphuretted hydrogen, precipitates sulphide of antimony, and hydrochloric acid is formed, the affinities of these elements being nearly balanced. To enable this precipitation to go on satisfactorily, the solution requires to be diluted, but the liquor of chloride of antimony is decomposed y dilution into an acid salt which remains in solution, and a basic salt which is precipitated; tartaric acid is added to the ater with which the liquor is diluted, the tartrate of antimony rmed being a salt which is not decomposed by water, but ich is still readily precipitated by sulphuretted hydrogen.

In all cases of precipitation, it is most important to take care that there has been sufficient of the reagent u to precipitate the whole of the element intended to thrown down, and equally necessary to wash the precipit thoroughly, that its weight may not be added to by t presence of soluble salts which ought to have been was out. With some precipitates the washing required is ve considerable, and should be continued in any case till t water comes through so nearly pure as to give no precipit with some delicate test for the bye-product.

Potassæ Permanganas.

Five grains of the permanganate of potash dissolved water require for complete decoloration a solution of 44 gra of granulated sulphate of iron, acidulated with 2 fl drachms of diluted sulphuric acid. Here we have a t which naturally brings us to the method of volumetric es mation, for we do not separate any element and weigh it, b simply estimate the quantity of one of the elements prese by the quantity of a reagent which it is necessary to add produce a certain visible change. The change in this ca being the conversion of the highly-coloured permangana into colourless sulphate of potash and sulphate of mangane

2 Na, or any other powerful base; but as it is more convenient to work with single equivalents of the alkalies, we adopt 63—the half equivalent—as our working number. A little confusion arises from the use of the term equivalent where molecular number would probably be less objectionable; 63 is really the equal value of oxalic acid when compared to HCl 36·5. This weight in grains or decigrams is to be dissolved in 100 measures of water, the measures being 10 grains or 1 gram each, according as English or French weights and measures are adopted. As the French weights and measures are very largely used now in analytical operations, I will employ them only for the present.

It will be readily seen, that if we take an equivalent in decigrams of an alkali, exactly the 100 measures of the acid solution would be required to neutralize it; and if the alkali contained any impurity, such as water, carbonic acid, or a neutral salt, so much less of the acid solution would be required, and the quantity of the acid left after neutrality had been attained would indicate the percentage of impurity in the alkali. If one-half of the sample were impurities, there would be one-half of the acid left. If the sample contained only 5 per cent. of impurity, 5 measures of the acid solution would be left, and so on.

For convenience, it is usual to prepare much more of the solution than is used for one operation, the solutions thus kept in readiness being commonly called normal solutions, or volumetric solutions. Sixty-three grams of oxalic acid, dissolved in as much water as makes up the measure to 1 litre or 1,000 cubic centimetres, constitutes the volumetric solution of oxalic acid of the British Pharmacopœia.

To facilitate the making of volumetric solutions, a graduated bottle is used for dissolving the reagent or mixing solutions which are too strong with the requisite quantity of water. For the oxalic acid solution nothing more is necessary than to put the 63 grams of crystals into the bottle with sufficient water to dissolve them, and, when solution is complete, to add water till the whole measures accurately 100 cubic centimetres or one litre. The cut (Fig. 43) represents the usual form of graduated bottle for this purpose. You will find other volumetric utensils and apparatus described and figured in Griffin's "Chemical Handicraft."

The next cut (Fig. 44) represents the burette and stand. The graduated tube may be compared to an elongated glass syringe with a piece of soft india-rubber tube drawn over the

Fig. 43.

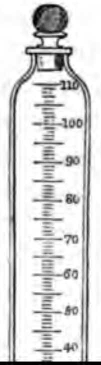
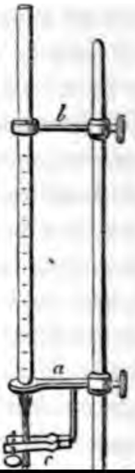


Fig. 44.



colour most distinctly, but a glass vessel being better adapted for observing the formation of white precipitates.

The white slab *d* is convenient for testing the oxidation of iron solutions as described in the Pharmacopœia under saccharated carbonate of iron, &c., a number of little spots of red prussiate of potash solution being placed upon the slab before commencing the operation; when the bichromate solution is run from the burette into the beaker, and a drop of the iron solution taken out from time to time with the stirring rod and let fall upon one of the drops of red prussiate, the action being complete when Prussian blue is no longer produced.

The burette should, in the first instance, be filled above the top graduation, and the excess allowed to run out by loosing the pinchcock, as it is much easier thus to get the level of the liquid exactly at the graduation; and, what is of more importance, it also insures the whole apparatus being filled down to the delivery point, and avoids the error which would necessarily arise if this were not the case.

The following table shows at one view the volumetric solutions of the Pharmacopœia, expressed in English weights and measures; but we have only to read cubic centimetres instead of grain-measures, and grams instead of grains, to convert it into the metric system :—

Volumetric Solutions.

	1,000 grain-measures contain grains.	Fraction of equivalent in grains.
Bichromate of potash, $KO, 2\ CrO_3 = 147{\cdot}5$	14·75	$\frac{1}{10}$
Hyposulphite of soda, $NaO, S_2O_2 + 5\ HO = 124$	24·8	$\frac{1}{5}$
Iodine, $I = 127$	12·7	$\frac{1}{10}$
Nitrate of silver, $AgO\ NO_5 = 170$	17·0	$\frac{1}{10}$
Oxalic acid, $2\ HO, C_4O_6 + 4\ HO = 126$	63·0	$\frac{1}{2}$
Caustic soda, $NaO\ .\ HO\ . = 40$	40·0	1

In the case of caustic soda an exact equivalent is taken; but as this material is not conveniently prepared and kept in a state of sufficient purity to be weighed out in this way, it is prepared from a solution which is known to be stronger than enough, estimating its strength by volumetric examination with the oxalic acid solution, and subsequently adding water to obtain the exact composition required. The Pharmacopœia gives a somewhat complicated calculation to show the dilution required in a given case. For illustration, 930 grain-measures are supposed to neutralize 63 grains of pure oxalic acid, and the calculation is to show how much water is to be added to 9,000 measures of this strength to reduce it so that 1,000 grain-measures shall be neutralized by 63 grains of oxalic acid, the formula being 9,000 × 1,000 ÷ 930 = 9,677. The 9,000 measures of solution of soda being put into a graduated measure, are to be filled up with water to 9,677. The simpler mode being thus:—The measure of 930 grains is found to contain as much soda as ought to be in 1,000 grain-measures; therefore take 930 measures and fill up with water to 1,000, and the desired result is obtained.

When we have to examine a definite chemical compound by volumetric analysis, and the reaction is of such a simple

402 grain-measures of volumetric solution of soda, we ght equally well use 1,108 grains, in which case 1,000 in-measures ought to be required, and any residue of la solution in the burette after neutrality had been reached uld indicate the excess of water in the vinegar; if 57 in-measures were left, we should consider that the vinegar l been adulterated with water to the extent of 5·7 per cent. e object of using 445·4 grains is to enable the operator to sure it with an ordinary ounce measure, this being the ght of a fluid ounce; but pharmaceutical measures scarcely nit of the quantity being estimated with the accuracy irable; either weighing, or the use of such measures as are le especially for volumetric purposes, should be preferred, l this would have the advantage of facilitating the conver- of the quantity required for the operation with English ghts and measures to the corresponding quantity in the ric system. If the 445·4 grains are to be weighed, the nge is perfectly simple, namely, take 44·54 grams; but if y are to be weighed, why take this odd number, including raction? If we are to estimate it by measure, it would be re likely to be done accurately by taking 1,087 grain-asures of vinegar to be neutralized by 1,000 grain-measures he soda solution, and then any one who might habitually cubic centimetres would simply take 108·7 cubic centi-tres to be neutralized by 100 cubic centimetres of soda ition, and the two measurements would naturally be more ly to correspond accurately with one another than would the case if a druggist's ounce-measure were used for the egar and a burette for the soda solution.

n operating upon solids it is usual to weigh an equivalent grains, or such fraction of that number of grains as cor-onds with the volumetric solution, taking into account number of equivalents that may be involved in the decom-tion.

nder the tests for carbonate of potash we are directed to 83 grains for the operation, which should require *at least*

980 grain-measures of the volumetric oxalic acid for neutralization; the fact being that it should require 1,000 measures, but a little latitude is reasonably allowed, as the mode of its production is intended to leave 16 per cent. of water combined with it, and it readily absorbs more if not carefully guarded. The use of only 980 grain-measures of the acid solution would indicate that the salt contained 2 per cent. more water than the theoretical quantity, or an equal quantity of some other impurity.

Under the head of volumetric solution of bichromate of potash, we find four preparations of iron are to be tested with it, and the quantity directed is 20 grains of salt, requiring diverse quantities of the chromate solution; and if the quantity actually needed is less, the deficiency does not so readily convey an idea of the proportion deficient. The following table shows the same testing calculated for the use of such weights as should require 1,000 grain-measures of the bichromate solution:—

	Grains.	Grain-measures.
Ferri arsenias . . .	117	1,000
„ carb. sacch. . . .	60	1,000
„ oxid. magnet. . . .	240	1,000
„ phosphas . . .	80	1,000

Used in these quantities, every ten grain-measures not required indicates 1 per cent. of deficiency in the substance

LECTURE XXVI.

SUPPLEMENTARY NOTES ON PHARMACEUTICAL TESTING.

Vinegar—Acids: Hydrocyanic, Sulphurous—Nitrate of Silver—Oxide of Silver—Lime Water—Saccharated Solution of Lime—Chlorinated Solution of Lime—Chlorinated Soda—Solution of Ammonia—Liquor Potassæ—Reduced Iron—Mercury with Chalk—Blue Pill—Solution of Subacetate of Lead—Quinine Sulphate—Rhubarb Powder.

Most of the tests officially described, as I have already said, afford satisfactory results if implicitly followed, but they have one general fault—that is, that they are too troublesome to be put in frequent operation by the consumers or dispensers of drugs. It is well that the manufacturer of chemicals should know what degree of purity is required of him, and be under the wholesome fear that a faulty preparation *may* be detected, and the detection bring with it the merited penalty; and the testing, which I have just said is too troublesome to be constantly in use by the dispenser, is not too heavy a demand upon the manufacturer; but the fact that in a very large proportion of cases preparations are subjected to no reliable testing at the hands of the retail pharmacist, is no doubt a temptation to negligence on the part of a manufacturer, and as a result we frequently find faulty samples of certain preparations in actual use. This is, perhaps, more the case with spirit of nitrous ether than with any other pharmaceutical; the makers offer it of "B.P. density" perhaps with a consciousness that it is not of "B.P. strength," and that it is beyond the power of most pharmacists to make a critical and reliable examination of it.

It is much to be desired that a complete system of testing should be elaborated, which would aim at a less ambitious degree of perfection than that which is upheld—and justly upheld—by professional analysts, but which should be so readily applied that an ordinary dispenser should feel no more hesitation in taking up the examination of half a dozen chemicals, than he would in dispensing as many ordinary mixtures.

The use of volumetric apparatus and solutions should not under present circumstances be expected of the dispenser in the daily performance of his business; but if the results which are desired can be obtained by the use of ordinary dispensing appliances, it would not be too much to expect of the dispenser that he should frequently examine those preparations which are most liable to deviate from the official standard, and that he should make a critical examination of other pharmaceuticals from time to time as circumstances might dictate.

The testing of vinegar with chloride of barium gives us the clue to the system which I think most likely to be adopted with general satisfaction. A small percentage of sulphuric acid in the vinegar is permissible, as much chloride

gents such chemicals as are in constant use in a state of
able purity; to make the testing dependent upon chemicals
more reliable than those we desire to examine, or upon
as would have to be procured especially for analytical
would be quite contrary to the lines I have laid down.
pensing scales and weights of fair ordinary quality will
rd all the accuracy required for the present purpose; but
maceutical measures, however correctly they may be
luated, scarcely allow of such precision in estimating
mes as would encourage us to use them except where
hing is inconvenient. A fluid ounce of liquid in an
nary ounce measure may vary 5 per cent. on either side
ccuracy, even when measured by a careful hand; but in
hing, the error is not likely to exceed one-tenth of this
ortion, except in the weighing of small quantities. We
t, therefore, give our preference to weighing, and to operat-
upon such quantities as do not involve especial nicety on
one hand, or wasteful expenditure of material on the
r. What is most to be desired, is to have certain narrow
ts of variation fixed which can be readily conformed to,
the deviation from which can be readily detected without
g beyond the common appliances of the dispensing
ter. I propose now to draw your attention to a few cases
re I think a change in this direction may be readily
ted, either by a modification of the B.P. process, or any
rs which may occur to us.

Acidum Hydrocyanicum.

he deterioration of this acid by keeping renders it im-
tive to have its strength watched, not only on receipt of
stock, but at times when the stock of an acid which was
ct when new has become doubtful by keeping; it may
sted as follows:—Take 2 fluid drachms of the acid, add
id drachms of liquor of potash, and then add crystallized
te of silver 6½ grains, which should produce a precipi-
dissolving as soon as formed; the precipitate being

permanent, would indicate that the acid was unfit for use. The addition of half a grain more of the nitrate of silver should produce a permanent precipitate; its failure to do so would indicate that the acid was above its official standard. For small consumers, the best policy is to throw away a sample which is incorrect, and replace it; but if the bulk of acid in hand be so large as to justify a careful experiment and calculation, the excess or deficiency may be readily ascertained by the quantity of acid or nitrate of silver it required to bring the 2 fluid drachms under treatment up to the point of saturation; thus, if the acid be deficient, the precipitate with 6½ grains nitrate of silver being permanent, and it was found by gradual additions of more hydrocyanic acid that another drachm was required to re-dissolve the precipitate, then 3 drachms of the acid equal 2 of B.P. strength. If, on the other hand, the gradual addition of nitrate of silver failed to make a permanent precipitate till 3¼ grains more had been added, then 2 drachms of the acid equal 3 of B.P. strength, and would be rectified by the additional drachm of water; or 3 drachms of the weak acid and 2 of the strong would yield 5 of official strength. Thus a stock of deteriorated "Scheele's acid" would enable ficulty in preserving it thus if originally correct. An acid half the strength would probably be a better standard to m at. The testing is most conveniently performed as llows :—Take 12 grains of iodine in a small earthen mortar th a few drops of water, and, while triturating, drop in adually from a minim tube with elastic ball the sulphurous id, noting the number of minims which are required for mplete decolourization of the iodine. The end of the retion is quite sufficiently clear without the use of starch, d the approach towards the end is so clearly indicated by e diminishing depth of colour, that the final drop of acid n be judged without hesitation. The acid being contained a closed minim tube during the operation, prevents loss by aporation.

Argenti Nitratis.

Crystallized nitrate of silver, as commercially met with, is nerally nearly pure, quite sufficiently so for pharmaceutical e, the principal impurities it contains being a little free acid d water, occasionally a trace of copper, and rarely nitrate potash as an adulterant; the latter addition is sometimes ade to the fused caustic where a milder action is required. n testing, we adopt pure chloride of ammonium, a salt hich scarcely contains any trace of impurity but water if be used in the crystallized state, or a trace of iron if the blimed salt be employed; either condition will answer quite ell if free from adhering water.

Put 17 grains of the nitrate of silver into a 3-oz. bottle th 2 oz. of water and 2 drachms dilute nitric acid; then add grains of pure dry chloride of ammonium in powder, and ake briskly; a curdy precipitate should separate, leaving the pernatant liquid bright. This clear liquor should yield a rther precipitate on the addition of a little more chloride of monium or hydrochloric acid.

Argenti Oxidum.

Oxide of silver frequently contains carbonate and somees other impurities; it may be tested on the same principle

as the nitrate, the first step being to convert it int
the second step being to show that the legitimate p
of silver is present.

Take 11 grains of oxide of silver and dissolve it
nitric acid in a 3-oz. bottle (effervescence will
presence of a carbonate as an impurity); when disso
water to make 2 fl. oz., and then 5 grains of
chloride of ammonium in powder, and shake bris
curdy precipitate having subsided, the clear liquo
yield a further precipitate on the addition of more
of ammonium.

Liquor Calcis.

Lime water is easily made and easily preserve
strength if kept in a cellar, and in contact with an
lime, but when the clear solution is decanted and pl
bottle for occasional use, the causes of rapid cha
into action. The cheapness of the article suggest
should at any time throw away the contents of
bottle and replenish from the cellar rather than
trouble of testing, but it is an advantage to know w
not the customary keeping in the warm shop, with
opening, renders it unfit for use before it is consu

from any wilful negligence. A fluid drachm of the solution mixed with 4 oz. of water, 20 grains of iodide of potassium, and 2 fluid drachms of hydrochloric acid, has a brown colour, which, on adding 11 grains of hyposulphite of soda, becomes pale yellow, and by the addition of another grain of the hyposulphite is quite decolourized. If the 11 grains of hyposulphite cause complete decolourization, the solution is below strength; and if, on the other hand, the additional grain of hyposulphite fails to decolourize it, there is an excess of the available chlorine. If it be desired to know how far the solution deviates from the official standard, the operation may be reversed. Take 4 oz. of water, 20 grains of iodide of potassium, 2 drachms of hydrochloric acid, and 11 grains of hyposulphite of soda, and add by degrees the solution of chlorinated lime, noting the quantity required to produce a permanent very pale yellow colour; the quantity of solution thus indicated is equal to a fluid drachm of the official solution.

Liquor Sodæ Chloratæ.

A fluid drachm mixed with 4 oz. of water, 20 grains of iodide of potassium, and 2 fluid drachms of hydrochloric acid, has a brown colour, which, on adding 10 grains of hyposulphite of soda, becomes pale yellow; and by the further addition of a grain of hyposulphite becomes quite decolourized. This testing may also be performed in the reverse order as described under the testing of solution of chlorinated lime.

Liquor Ammoniæ Fortior.

A fluid ounce (390 grains) neutralizes 470 grains of pure oxalic acid. The acid being dissolved in half a pint of warm water, and coloured red with litmus, should have the ammonia poured in in full stream with constant stirring to avoid loss by escape of ammonia during the process; the liquor should then have a violet colour and should become blue on adding 30 drops more ammonia, or red on adding 30 grains more of the oxalic acid. The colour change is not very sharp, but f pharmaceutical use a deviation from standard not exceedi 30 grains per ounce, may be considered a practicable limit.

Liquor Potassæ.

A fluid ounce of liquor potassæ (462 grains), tinted bl with litmus, remains blue when 29 grains of oxalic acid h been dissolved in it, but becomes red on adding 1 or 2 gra more.

Ferrum Redactum.

Reduced iron is a very unsatisfactory chemical, the obj sought being to have iron in a fine state of division eas acted on by the fluids of the stomach. Iron in this conditi would necessarily be easily acted on by a moist atmosphere, that the reduced iron, if obtained in the condition theore cally considered desirable, is essentially an unstable artic According to the B.P. standard it should contain half weight of metallic iron, and, if so, its quality may be sho as follows:—7 grains with 16 grains of iodine and ½ oz. water, warmed in a small flask or test tube, should form solution almost free from colour, holding in suspension dark insoluble powder. The continuance of a brown iodi siderable delicacy is the precipitation of metallic mercury upon a clean copper surface. A clean copper coin being half immersed in the filtered hydrochloric solution, should not in the course of several minutes show a white stain on the part immersed. The pharmacist should also guard against a deficiency of mercury if, as is generally the case, he buy this preparation rather than make it. This may be done as follows:—

Take 30 grains of grey powder, rub it in a mortar with 20 grains of iodide of potassium and 12 grains of iodine, adding a few drops of water to reduce it to a soft pulpy condition; the colour should shortly become pale grey with only a tint of yellow. The continuance of a brown colour would indicate deficiency of mercury. Thirty grains of the grey powder should contain 10 of mercury, which would combine with 12·7 of iodine to form red iodide of mercury; which, in turn, would combine with the iodide of potassium to form the pale yellow iodide of mercury and potassium. The use of 12 grains instead of 12·7 of iodine allows for a little oxidation and small errors.

Pilula Hydrargyri.

Blue pill may be tested in precisely the same manner as grey powder, using the same quantities of material and reagents; but the dark colour of the excipient prevents a direct colour indication of the end of the iodine action, so it becomes necessary, after the lapse of an hour or two, to dissolve in water, filter, and note that the pink brown filtrate does not become paler on the addition of a grain or two of hyposulphite of soda, which would be the case if it still contained free iodine consequent upon deficiency of mercury.

Liquor Plumbi Subacetatis.

The strength of this solution is most readily indicated by its gravity. I have not been able to find a test by precipitation which I could recommend as being at once more easy and

sufficiently accurate. The density required by the B
1·26, but when made by B.P. process the density prac
obtained is 1·289. The specific gravity may be readily
to the second decimal place, which is quite close enoug
case of this kind, by the use of a stoppered 2-oz.
and a pair of ordinary scales. Fill the phial with
drop the stopper in, and take the gross weight. Subtra
tare, and note water = W (say, 960 grains). Repe
same with liquor plumbi, and find its weight = P (say,
grains); then P × 1,000 ÷ W = specific gravity
1·288), and supposing the scales which would be us
weighing this quantity would not accurately indica
weight within a grain or two, the gravity is still correctly
to the second decimal place, and approximately to the t

Quiniæ Sulphas.

The pharmacopœial tests for quinine are not abso
satisfactory, and the recent refinements of the same pr
while giving more exact results, add a little to the compl
While I do not think it likely that any process of a s
character will be found to establish incontrovertibly the

occur during the maceration, the quantity dissolved would be increased, and, to obviate a misconception, heat should be avoided.

Powdered Rhubarb.

As I have already pointed out, commercial rhubarb powder is generally improved in appearance by the addition of a little oil in the grinding; the quantity is usually too small to be looked upon as an adulteration in the ordinary sense of the word, but yet it is sometimes a source of much annoyance to both pharmacist and patient from the great difficulty experienced in mixing compound rhubarb powder with water when the oil is present in appreciable quantity. One hundred grains shaken up with 1 oz. of benzine and thrown upon a paper filter, should yield a residue on evaporation of the filtrate, which should be yellow, unctuous, and not more than half a grain in weight.

Good commercial powdered rhubarb generally yields more oil than this, but the analyses of unground roots have yielded much less.

LECTURE XXVII.

PHARMACY OF SPECIAL DRUGS: CINCHONA AND OPIUM.

BESIDES the study of the chemical and physical forces which form the base of the pharmaceutical edifice, and the processes of official and extempore pharmacy which constitute the ordinary superstructure, there is yet another addition to the building which may be considered the pinnacle of pharmaceutical science, and consists of such a general and critical view of all that we have learned as will enable us to detect the failings in any process, or in the special application of any process, and devise improvements in the same. This task is one for which the tyro in pharmacy is necessarily unqualified, and which, when undertaken even by those who have grown old in the art, forces upon them the consciousness of how many problems there are yet to be solved. I would wish you to feel that in treating this part of my subject I do it purely in the spirit of a student. I speak not as one having authority, but as one who, having made some progress in his subject, is feeling his way to further advances.

You might perhaps ask why I, occupying as I do the position of a teacher, should come before you proposing to treat of problems upon which I cannot speak authoritatively; and I might reply that I do not know any lesson of greater l illustrating by my example, the spirit of an investigator the field of practical pharmacy. I propose to draw your ention to the direction and manner in which I think the armacy of one or two drugs might be advantageously died, pointing out the bearing of any recent experiments, d the direction in which further experiments seem de- able.

We may lay down as axioms of the pharmacy of vegetable ugs that the product must have—

1. The right kind of therapeutic or physiological action.

2. Uniformity in degree of activity.

3. Permanence in value.

4. It must be obtained with as little cost of time, labour, l material as practicable in carrying out the previous uirements.

CINCHONA.

Turning our attention first to cinchona, we have to con- er what preparations of cinchona, official and non- cial, best meet the requirements of the axioms just laid vn.

Among the cinchona preparations sulphate of quinine nds pre-eminent,—its therapeutic action being so nearly same as that of the entire bark, that we may say, when chona is indicated, quinine is equal to the occasion. It s also the advantage in the second requirement, viz., at while bark is variable the quinine is constant; and s advantage is one that it holds equally when brought o comparison with the galenical preparations of the rk.

The pharmacist's duty in relation to the preparations of chona will be mainly confined to the testing of the raw terial, the examination of the efficiency of the extraction it is subjected to, and the examination of his preparati from time to time to guard against deterioration by keepi and by this means he will probably aid in the improvem of some processes, promote the expunging of others, and his small measure expedite the coming of that day when application of remedies will be reduced to a scient system.

First, as regards the extraction of the active principl no method by water only gives good exhaustion. A extracts much bitterness after treatment with water ceased to give a liquor worth having. Maceration w sulphuric, acetic, or hydrochloric acid before treatment w water improves the exhaustion, but even after macerati finely-powdered bark for some days with acid a subsequ percolation with water fails to extract all the bitter principl the alternate treatment with acid and water being necess to effect complete exhaustion by percolation without heat. maceration for some months with acid, brings the alkalo into a condition in which percolation with water is capable effecting proximate exhaustion; but during protracted tre ment with acid some change takes place, resulting in loss of alkaloidal value. In the use of sulphuric a

Spirit extracts cinchona better than water, and the tincture may be rapidly concentrated by distillation without the precipitation or any notable decomposition of the active matters; the most satisfactory preparation of cinchona yet produced being that obtained by percolating the powdered bark with spirit and distilling off the excess of spirit. The B.P. defines the quality of bark as containing not less than 2 per cent. of quinine; but as bark of this quality does not yield a fair approach to this quantity by any pharmaceutical process, t would be better to define the alkaloidal value of some one good galenical preparation, and discontinue the use of the others. Thus, supposing spirit to be the best solvent for obtaining the whole of the valuable constituents of bark, an alcoholic liquor made by percolation should be reduced by distillation of the spirit till the concentrated liquor contained by assay 2 per cent. of quinine, or 4 or 5 per cent. of total alkaloids. Such a preparation would no doubt still waste some small portion of the alkaloids difficult to extract from the marc, but not so much as any of the galenical preparations now do, and would have a pretty close approach to constancy of value, which is the most important of all points in therapeutic agents. This alcoholic liquor of cinchona could be diluted with water to take the place of the customary infusion and decoction, or could be given along with ammonia or acids when these were indicated.

It may appear almost too much to expect the pharmacist to make an assay of every batch of such alcoholic extract he may make, but I see no probability of really good cinchona galenicals till this is done, and I do not regard any one as competent to make such galenicals who is not competent also to make their analysis. The process for this alcoholic liquor may probably be improved upon, but I do not think any deviation will be acceptable which does not include the alkaloidal assay.

OPIUM.

The principal points which claim our attention in connection with the pharmacy of opium are somewhat different from those which were considered most important in the treatment of cinchona. Though the complete exhaustion of opium is not very readily effected, the official processes all afford a fair approximation to this result. In making a preparation of cinchona, the principal object was to separate the bulk of inert matter; in making an extract of opium (using the word extract in its wider sense), our aim is to separate matters which are considered to have an objectionable action, and to retain one or more principles which possess beneficial properties.

The therapeutic value of opium depends mainly, but not exclusively, upon the morphia it contains, the action of the morphia being enhanced or modified by the other constituents, which are very numerous, but not very active in the small quantities in which they are present. Narcotine is the only one of the crystallizable principles present in notable quantity, and it is credited with an exciting rather than a sedative action.

As opium is often prescribed in the crude state, simply dried and powdered, the first and most important step is to assay the raw material, and accept none for pharmaceutical ined may be evaporated in a water bath, the percolation g continued so long as the bitter taste indicates the action of active matter. The spirit thus extracts all the loids, vegetable acids, resin, and odorous matter, and es in the marc the vegetable fibre, earthy matter, and gum. tincture being evaporated to about ½ oz., an equal me of water should be added, and the evaporation inued till a syrupy aqueous liquor is obtained; then add . of water, which throws down a large quantity of brown ter (so-called resin) and narcotine; these are usually so ty and adhesive as to allow of ready separation and hing; the liquor may be filtered through a small plug otton wool moistened with spirit. The filtrate, after entration to 2 drachms, is to be mixed with an equal sure of spirit, and rendered alkaline with a few drops iquor of ammonia. In the course of twenty-four hours, morphia and narcotine will have deposited as a crop of tals; these being collected on a small weighed filter, are e washed with spirit and water, mixed in equal parts, so as colour is thus extracted, then washed with cold water, drop on evaporation leaves a very small residue; the then contains morphia and narcotine; after drying, the ine may be washed out with benzine, and as soon as the e has evaporated, the morphia, which is now almost ay be weighed. It ought to be 10 per cent. of the of the crude opium in its dry state. Commercial are very variable, and are often above as well as is standard; the weak and strong samples should nded as to result in a percentage within a fraction of f this standard.

ide opium of suitable quality having been obtained, st part of the difficulty of obtaining satisfactory ns has been removed.

nd spirit are both efficient solvents of the active s of opium. Spirit gives the most complete re-

presentation of the crude drug, and effects the exhaustion
readily, but water is considered to give the more sed
solution from its dissolving less of the narcotine and
odorous and resinous principles. If it be desired to o
the morphia in its natural state of combination, more
from narcotine than is practicable by simple extractio
cold water, a further portion of the narcotine ma
separated by repeated evaporation and dilution, especial
the acidity which commonly belongs to opium has
neutralized by the addition of chalk previous to filtr
In working from a standard opium, either with spi
water, there will be no difficulty in producing a tinctu
aqueous liquor of sufficiently correct morphia value wi
the necessity of assaying each batch; but if the operatio
commenced with the crude drug of unknown strengt
assay of the liquor is essential, and should be perform
exactly the same manner as the latter part of the oper
for estimating the morphia in crude opium.

The extract of opium of the present Pharmacopœ
unsatisfactory, because of its being no more unifor
reliable in potency than the opium from which it is prep
and this defect would appear still more conspicuous i

brought to the standard of 20 per cent. of morphia calculated on the extract in a dry state.

A satisfactory liquid extract of opium may be made by following the process indicated for analysis up to the point at which ammonia is to be added; at that stage a sample should be taken, the morphia estimated, and then the bulk of the liquor reduced to the required morphia strength by adding water.

LECTURE XXVIII.

PHARMACY OF SPECIAL DRUGS: ALOES, RHUBARB, SENNA, JALAP.

ALOES.

THERE is no drug in all the materia medica more frequently used than aloes, and few which require less preparation in the hands of the pharmacist. Under ordinary circumstances the pilular form is the best for its administration, and when the aloes is of good quality, drying and grinding are the only treatment it requires to fit it for the dispensing counter. Its activity is but little if at all increased, and the irritating action on the bowels is not much diminished by the aloes being converted into an aqueous extract, or by the use of the pure crystalline principle, aloin. Authorities differ on these points, and probably the more so from the experimenters

Aloes is very little changed by keeping either in the ilular or dry condition, but undergoes change, losing itterness and activity when its watery solution is exposed the air, especially in the presence of alkalies or their rbonates. The activity is almost entirely lost if the solution water with carbonate of potash is evaporated in the water th to a pilular consistence, the residue being entirely luble in water, and only having a slight bitterness. imilar evaporation in the absence of alkali renders a small ortion of the aloes insoluble in water (but still soluble in lkaline liquors), inactive, and almost tasteless. In the pre-ence of acids the change by exposure to air is slow, repeated vaporations extending over a month having less effect than single evaporation during a single day in the alkaline olution. Neither acid nor alkaline solution of aloes undergoes ny rapid change if not exposed to air and light. Boiling the loes with carbonate of potash, as in the official decoction, iminishes its bitterness and probably its activity even when he air is excluded as far as practicable. If there be any dvantage in administering aloes in the form of decoction, it probably better to have the decoction either recent or so ar protected from the air as not to lose any considerable pro-ortion of its bitterness and activity. It is not desirable to ave a preparation losing strength, however much it may mprove in flavour by keeping. Tincture of aloes may be garded as a permanent preparation; it undergoes very little hange by keeping, but is extremely nauseous. The pilular rm is no doubt the best in which to exhibit aloes in all rdinary cases, and soap is a good excipient for increasing the lubility. Though the alkaline character of soap would robably facilitate the oxidation, and so detract from the tivity of an aloetic liquor exposed to the air, this ten-ency is observed to a very small extent in the aloetic lls containing soap, to so small an extent, indeed, that r all practical purposes we may consider them unchanged keeping.

RHUBARB.

This very valuable and popular drug has several preparations in constant use that are suited to almost any occasion where the employment of the drug is indicated. The point which most prominently presents itself for improvement is the nauseous taste, which to many patients is very disgusting. The taste is no doubt the combined effect of various constituents, some at least of which could not be removed without loss of value; but the odour, which is no less objectionable, is usually attributed to an essential oil which there is no reason to suppose has any therapeutic value. The rhubarb powder may be in great measure deprived of its odour by long-continued percolation with chloroform, the matter extracted being a soft yellow unctuous body with a strong offensive characteristic odour of rhubarb. The rhubarb which has thus been deprived of its odour does not continue odourless, and, as far as I can observe, the odour is developed by the action of air and moisture on the deodorated powder. My experiments upon the removal of the odour of rhubarb some years ago led me to the observation that the bulk of the powdered rhubarbs ease after evaporation. If the sample will stand this test may be considered sufficiently free from oil, natural or ded, to be fit for making Gregory's powder. The com- und rhubarb pill, and tincture of rhubarb, are two very isfactory preparations, and together with the simple and mpound powder afford all the facilities required for the ministration of this drug in almost any case. The infusion d syrup have not had the same extended use; the latter is bject to fermentation, and would probably be better made adding a concentrated tincture to syrup. A concentrated cture suitable for this purpose may be made by percolating ely-powdered rhubarb with spirit. Rectified spirit perco- es most readily, but takes up resinous matters which immediately precipitated when the tincture is diluted h water. If the tincture be diluted with syrup, the cipitation of resin is very much less in degree, and takes ce very slowly. So far as I have had opportunity of erving, the syrup thus made is not prone to fermentation n when kept a considerable time at a temperature of ' Fahr.

Spirit of 20 or 30 overproof percolates more slowly; and h proof spirit, the percolation almost ceases unless aided a little extra pressure. Using fine powdered rhubarb, tified spirit, and the percolator (Fig. 33, p. 128), which have described as useful for the exhausting of small ntities of powders with the smallest practicable quantity spirit, the following form will give good results:—

Take of—

Rhubarb powder . . .	1 oz.
Rectified spirit . . .	2 oz.

Mix.

Macerate twenty-four hours, pour into the percolator, lower inner tube till it just rests upon the surface of the barb liquor, and then pour in rectified spirit till it covers inner tube, and keep it so filled till 3 oz. of percolate are ained. If the operation be well performed, the proportion of active matter left in the marc is insignificant. I have taken a dose of 40 grains of the marc, weighed in its dry state, without any effect; it is horny and mucilaginous like tragacanth, but dark grey in colour and nearly tasteless. The tincture evaporated leaves a resinous-looking and friable mass of a rich brown colour, readily powdered. The yield is no doubt variable, as some roots are much more mucilaginous than others; but the probability is that the alcoholic extract would be found more constant in activity than either the powdered root or the usual aqueous extract, and as it is separated from a considerable proportion of inert matter, there would be opportunity of giving a full dose of rhubarb in a moderate-sized pill—two 5-grain pills of this alcoholic extract being about equal to a scruple of the powder, which could not be made into less than about six pills of the same size. The alcoholic extract has not the intractable toughness which is characteristic of the aqueous extract. Two fluid ounces of the strong tincture, prepared as above, mixed with 14 fl. oz. of simple syrup, equal in activity the official syrup of rhubarb. Oil of coriander might be added if desired, or the presence of spirit might be avoided by reducing the tincture to an extract. The extract obtained

SENNA,

hen given without combination with other purgatives,
usually in the form of powdered senna or compound
uorice powder; the latter might much more appropriately
ve been called compound senna powder, and thus have
ved the confusion which is now a constant source of trouble
pharmacists, as to whether a prescription ordering com-
und liquorice powder is to be dispensed with the German
ticle containing sulphur, or the B.P. article containing
me, which latter would have been the only correct course
d it not been that the German powder had possession of the
me, and an established reputation and footing in English
armacy before the introduction of the British formula.
the two articles are now in current use here, it would be
sirable, on the issue of a new British Pharmacopœia, to
tain them both with distinctive names, perhaps most
propriately calling the present British preparation "com-
und senna powder," and that made by the German formula
ompound sulphur powder." The confection of senna has
g enjoyed a considerable popularity as a palatable laxative,
t its activity is dependent as much upon the other mate-
ls as the senna it contains. The senna contained in a dose
the confection being from 6 to 12 grains, while the senna
resented by a dose of infusion would be 40 to 80 grains,
d the senna represented by a dose of the tincture and
xture respectively would be 7 to 27 and 40 to 60 grains,
latter being accompanied by 90 to 140 grains of sulphate
magnesia. Senna mixture is probably the most reliable of
the senna preparations, but its reliability, if not its
ivity, depends mainly upon the sulphate of magnesia it
tains. If there is any activity at all in the dose, say, of
f an ounce of tincture of senna, representing 27 grains of
leaves, there ought to be a conspicuous activity in 2 oz.
the infusion representing 80 grains; but the imperfect
raction of the purgative matters renders it desirable to

supplement these preparations with adjuncts which ca depended on, and points to the necessity, if we are to p any faith in the utility of senna, to adopt some impr process by which the cathartic action of the drug c be insured, and its posology understood.

In syrup of senna, where there is no other purgative, dose, 1 to 4 fluid drachms, represents about 30 to 120 gr of the leaves, treated by a more effective system of extrac than the tincture or infusion. This is the best pharmaceut extraction of senna among the official formula, but it is free from the disposition to ferment. It is capable of provement by replacing part of the sugar with glycerine, increasing the proportion of spirit.

Some authorities say that the active principle of senn freely extracted by spirit, others say that the senna lea after they have been treated with spirit, are as active as bef I can only quote one personal experiment on this point: took half an ounce of powdered senna, macerated it in recti spirit for twenty-four hours, with agitation, poured the wh into a tubular percolator, and percolated in the manner scribed under opium extraction, page 128; the first portion percolate was dark olive-green, with a strong taste of senna, green matter insoluble in water. The brown watery liquor had a full senna flavour, and was taken as a dose without producing any decided laxative action, though this single experiment would not justify my saying that the extractive matter, soluble both in spirit and in water, was quite devoid of activity. The green matter soluble in spirit and not in water was next made into a draught; it might be considered to contain the chlorophyll and resinous matters of the senna. As dilution with water precipitates this extract, mucilage was used for its convenient suspension, and it was taken as one dose. It had a senna flavour much covered by the spirit (3 fluid drachms), a slight sweetness like liquorice, and a little bitter and aromatic taste. As far as effects were concerned, it might have been taken as a cordial. In general I have great respect for the testimony of Sir R. Christison, but in respect to senna, I think it is evident we cannot accept his statement that the active parts are freely extracted by rectified spirit. After this experience, I was not disposed to expect any active effects from the B.P. tincture of senna, and as an experiment took 1 fl. oz. for a dose and did not find any effect at all. It might well be removed from the list of official tinctures; and in the compound senna mixture a little addition to the compound tincture of cardamoms and infusion of senna would compensate for its omission.

JALAP.

The pharmaceutical preparations of this drug are almost limited to the powder and resin. The activity depends upon two resins, both of which are soluble in spirit, but only one soluble in ether, and both are purgative. The matter capable of being extracted from the root by water is mucilaginous and inert. I have taken a dose of the watery infusion, prepared by macerating 2 drachms of powdered jalap in 2 oz. of water for several days, with agitation, pouring the whole into a percolator, and adding as required more water till the percolate measured 3 oz.; this draught had a sweetish nauseous taste, but no activity. About 50 per cent. of the jalap is dissolved by this treatment, and all this inert matter is put into the official extract of jalap without any palpable advantage. It does not impart to the extract the property of emulsifying with water, which might be a possible advantage if attained, and which may be accomplished by treatment such as is used for the production of emulsions of other gum-resins. That portion of jalap-resin which is soluble in ether is closely analogous, if not absolutely identical with resin of scammony. The resins of jalap and scammony do not emulsify so well with water or dilute mucilage as many other gum-resins, but their solubility in soapy liquors facilitates their administration in the liquid form, when so required. The B.P. mixture of scammony-resin with milk, as a purgative draught for children, may, if desired, be replaced by an alkaline solution of the same resin, produced by rubbing the powder with B.P. soft soap and adding mucilage and water. Almond emulsion gives pretty good results, but caustic potash, aromatic spirit of ammonia, and some other alkaline liquors which I have tried, fail to give a satisfactory suspension of the resin.

The brown resin of jalap, or the white jalapin of commerce, may be emulsified with soap in the same manner. Four resin in a state of suspension, or along with powdery matters, such as rhubarb and magnesia, to which the precipitated resin may adhere, and be protected from adhesion to the sides of the bottle.

The administration of jalap, either as its simple or compound powder, requires no comment.

LECTURE XXIX.

PHARMACY OF SPECIAL DRUGS: GUM-RESINS, ESS OILS, ETC.

Gum-Resins: Ammoniacum, Assafœtida, Guaiacum, Myrrh, Tolu Copaiba—Essential Oils—Liquid Extract of Male Fern.

GUM-RESINS, ETC.

IT may be desirable to give some few general c
upon those articles of materia medica which are of a
and resinous nature, and then a few words appli
vidually to several of them. Ammoniacum, assafœt
myrrh are good typical cases; they are partially so
water, capable of being made into emulsions by ap
treatment, partially soluble in spirit, which probably
from them all that is of therapeutic value, and the

mortar, not adding more till the lumps have entirely disappeared. Occasional rubbing, with intervals of an hour or more, will, without much labour, reduce the whole to a smooth pulp, *dissolution*, if not solution, being more complete than it would have been by the action of alcohol, and with the advantage that dilution with water subsequently does not cause an inconvenient separation of the resins, which are diffusible, though not soluble, in the menstruum which is ultimately the vehicle for the administration of almost every medicine given in the liquid form. The influence which one body exerts upon the solubility of another, should never be lost sight of in studying a problem of this kind. The gum-resin, reduced to coarse powder, and shaken with a bulk of water, will not readily produce so perfect an emulsion as the same ingredients used ultimately in the same proportion, if treated with the small proportion of water in the first instance, as directed above. Guaiacum, on the other hand, which is almost insoluble in water, dissolves into a thick, syrupy fluid with an equal weight of rectified spirit, and this, on dilution with double this quantity of spirit, becomes more turbid, and slowly deposits a portion of the guaiacum, neither water nor spirit producing a satisfactory emulsion by simple treatment. Mechanical powdering is scarcely so satisfactory a division of a resinous body as could be wished to insure its best therapeutic action ; nor are we any better off if the resin be dissolved in spirit, as separation takes place on dilution with the water required to make the dose potable. Where an emulsive condition is practicable, it is generally to be preferred for the administration of resins, gum-resins, oleo-resins, balsams, resinous extracts, and some essential oils, unless the dose be so small that they may be given in pills.

AMMONIACUM.

The dose of this gum being 10 to 20 grains, its administration in the pilular form is not convenient excepting where it is an adjunct to more active remedies ; and the fluid form officially recognized is a simple emulsion—¼ oz. of the gum rubbed with 8 oz. of water and strained through muslin—the formula apparently leaves little to be desired, and little room for comment, the most important point being the action of time. Rubbing the gum with a small quantity of water before dilution makes a more perfect mixture, as evidenced by the following experiment:—One ounce of gum-ammoniacum beaten with water into a soft pulp and rubbed occasionally during two days, water being added to compensate for evaporation, then made up to 2 fl. oz., allowed to subside, and the creamy portion decanted; the sediment further rubbed with portions of water, and the milky portion again decanted till the decantates amounted to 2 oz. A creamy emulsion was thus produced, which keeps well and is theoretically half the strength of the dry gum; but ½ oz. of it mixed with 7½ oz. of water makes a good emulsion more sapid than the B.P. ammoniacum mixture, though prepared with the official materials used in the official proportions.

Tinctures of ammoniacum have been adopted in some cases with the view of having a more concentrated preparation than the official mixture, and capable of yielding its medicinal equivalent by adding 1 drachm to 7 drachms of monly obtained by the old process, can easily be adjusted to the requirements of the patient by increasing or diminishing the dose prescribed; but a formula which, with every intention of fidelity on the part of the operator, gives results differing at one time from those obtained at another time, or by another dispenser, is a source of annoyance to the prescriber, and shakes the confidence of the patient.

ASSAFŒTIDA,

For internal use, is generally given in the form of pills, its offensive taste and odour almost prohibiting other modes of administration. Before making into pills, it requires to be freed from the mechanical impurities, such as splinters of wood or bark, which are commonly present in the crude gum. These are better separated by powdering and sifting than by straining; but the softness of the gum necessitates some assistance in the operation, the best being a low temperature. A sufficient supply should be powdered and sifted during frost to last over the warmer part of the year, and the powder thus obtained will remain fit for pill making even in hot weather; for though it may become a hard mass, it is free from foreign matters, and may be beaten with other materials into a satisfactory pill-mass. When it is necessary to keep assafœtida in a powdered state, it may be conveniently done by softening the gum in a water bath, and incorporating with it one-tenth of its weight of calcined magnesia; when cool this becomes hard enough to be powdered at any season, and retains its pulverulent condition. In dispensing it, however, the presence of the magnesia must not be overlooked.

For the production of an emulsion, in which condition assafœtida is used as an enema, the soft gum should be preferred, and the gum beaten to a soft pulp with a small quantity of water before adding the bulk. The addition of other mucilaginous bodies is not essential, at least if the emulsion is to be used soon after making. When the tincture of assafœtida is prescribed for internal use, it is better emulsified with mucilage of acacia or tragacanth, pouring the tincture into the mucilage in a mortar, with constant stirring—equal volumes are suitable—adding water to prevent the mixture becoming very thick before the final additions of the tincture are made.

The fœtid spirit of ammonia is a much less potent preparation as far as the action of assafœtida is concerned; it is also less nauseous, and its pharmaceutical manipulation requires no comment.

GUAIACUM RESIN.

Though commonly spoken of as gum-guaiacum, this substance is more purely resinous in its character than ammoniacum, assafœtida, or myrrh. It does not readily yield an emulsion worthy of the name, long trituration with water, in large proportion or small, failing to effect a true disintegration of the mass. Its dose is said to be 10 to 30 grains, but in the form of ammoniated tincture the dose is 6 to 12 grains. Probably the resin, given in powder suspended in water, is wanting in activity, consequent upon its insolubility and the official, allows the subsidence of part of the resin as a layer of deposit which is not readily shaken up; this rough, imperfectly suspended matter might be removed by straining through muslin with as much reason and propriety as this is done in making the mixture of ammoniacum, but I must add, with as much dissatisfaction and impropriety, for in both cases it involves the loss of some—and it is an indefinable quantity—of the active matter. Our first aim—a constancy of therapeutic value—is thwarted by the inability of the process to yield a satisfactory emulsion. A better method is to convert the resin into a tincture, to dilute that tincture with an equal bulk of glycerine, which forms a clear, brown, syrupy solution, and to pour that solution, with constant stirring, into a thick mucilage of acacia or tragacanth, lastly adding the water to give the required bulk.

An ounce of powdered resin of guaiacum, rubbed with ¾ oz. of rectified spirit, produces a thick, syrupy solution, nearly clear, which becomes more turbid on adding more spirit; and if it be required to produce a concentrated tincture, it is better to dissolve in a larger quantity of spirit, and, after filtration, reduce the bulk by distillation. But a little spirit can scarcely be objectionable under any circumstances where the use of guaiacum mixture would be appropriate, and it is quite convenient to make the tincture as follows:—

Take of—

Powdered guaiacum-resin . .	1 oz.
Rectified spirit . . .	3 oz.

Macerate, with occasional agitation, for twenty-four hours, then settle and decant the clear portion, throwing the sediment on a paper filter; after it has drained, pour on the surface of the contents of the filter ½ oz. of rectified spirit, or as much as may be required to make up the total measure of the filtrate to 4 fl. oz. This forms a strong tincture suitable as a basis for the production of an emulsive mixture of guaiacum as follows:—Take of the strong tincture of guaiacum, 1 oz.; glycerine, 1 fl. oz.; mix, and pour, with constant stirring, into mucilage of tragacanth, 10 oz.; then add water (or cinnamon water) sufficient to make 1 pint. Mixture of guaiacum made in this way does not settle rapidly and is easily shaken up; it is nearly white, milky, and free from grittiness. If mucilage of acacia be used instead of tragacanth, it settles more readily, though it is still much superior to the old form; it also speedily acquires a blue-green colour.

MYRRH.

Myrrh is possessed of very little therapeutic value; some authorities say it is without medicinal effect, others attribute to it a modifying action upon aloes and some other drugs, but the cases in which it is prescribed for its own action are almost confined to gargles and dentifrices, its utility in these preparations depending upon it being a pleasant aromatic antiseptic. I have already said that myrrh may be converted into a creamy, smooth emulsion by the action of an equal weight of water with occasional rubbing in the mortar and soaking between whiles, extending over several hours. This emulsion may be diluted with water, glycerine of borax, or other menstrua without further separation, except a slow sub-

BALSAM OF TOLU AND GUM BENZOIN

ve but little therapeutic value, and are perhaps more used lavouring agents than as actual remedies. Their tinctures y be considered to represent all the properties of the drugs pectively, but have the objection for internal use that y do not bear the requisite dilution with water without ering the inconvenient separation of the resinous matter. the flavour only be aimed at, the watery solution may btained clear and aromatic by adding the tincture to the er, and after the bulk of the resin has precipitated, ing a small addition of sulphate of alumina, and then an valent of hydrate or carbonate of potash; the precipitated aina then takes down with it the resinous matter which suspended in too fine a state of division to allow of ration by filtering paper without such assistance. By this iod a bright aromatic syrup of tolu may be obtained, h, however, does not contain the acids of the balsam which resent in the syrup produced by the official process. The amic and benzoic acids are apparently of little or no cinal value, and it is mainly for the sake of their atic qualities that these two gum-resins are used; if it be ed to administer their resinous constituents also, that is conveniently done by operating in the same way as ibed for guaiacum. The tolu and benzoin dissolve well trong spirit, but the tincture does not so well bear ions of water or glycerine, though it bears the latter r than the former. To make an emulsion, the process be the same as that given for guaiacum mixture, t that the tincture should be half the strength; the rtion of tragacanth or acacia in the ultimate mixture d not be less than there indicated, and the mixture e tincture with the glycerine should be made at the nt when required, as separation of the resin comes so soon as the glycerine is added to the tincture, and would probably not yield so good an emulsion if the tincture and glycerine were kept ready mixed for any length of time.

Copaiba.

The dose of copaiba balsam is such as almost to necessitate its being given in the fluid form. Capsules holding 20 grains are too large for convenient swallowing, and the full dose being a fluid drachm, several such would have to be taken at a time if the full dose were demanded. The nauseous character of the drug is an obstacle to its administration in the form of electuary. The emulsion, and soluble solution, are the two forms which most generally find favour, and of these the emulsion best represents the total activity of the drug. Copaiba is readily emulsified either with mucilage alone or with the addition of solution of potash. Spirit and spirit of nitrous ether form imperfect mixtures with the balsam, and aid its division in water, but are much less effective for this purpose than mucilaginous matters, and if added to a mucilaginous emulsion tend to cause its separation. The balsam, if heated with solution of carbonate of potash, dissolves some of the alkaline salt and becomes balsam of copaiba, 24 oz.; liquor of potash, 48 oz.; water, 120 oz.; boil together, and when cooled to 140° Fahr., add spirit of nitrous ether, 12 oz.; allow the mixture to stand a few days, separate the clear solution from the sediment and from the supernatant oily fluid. If the solution cannot be obtained clear by filtration through paper it may be shaken with magnesia or Fuller's earth—about 10 grains to each ounce—and the filtration repeated. Some writers say that magnesia used in this way has the power of removing "copaiba" from its solution in caustic potash, a statement which is not sufficiently definite to have much value, and to which I do not attach much weight. The solution made as above has much the same taste after agitation with magnesia and filtration as it has before, and probably has much the same activity. Authorities generally are agreed that the chief activity of the balsam resides in its essential oil, and it is more likely that the magnesia separates the resinous matter, leaving the oil in solution; but the same consideration would lead to the conclusion that the soluble alkaline solutions of copaiba must be deficient in activity, as the oil is not freely soluble in aqueous solutions of potash. It is not unlikely that each constituent of the drug has some therapeutic action, and that the presence of one affects the solubility of others. In the absence of a systematic investigation of the chemistry of this drug, and of the therapeutics of each of its constituents, the safest practice is to use such preparations as contain the whole of the balsam. The balsam being the product of various different plants, it is not to be expected that it can be quite uniform in nature, and it must not be supposed that a sample is adulterated because it differs from some other sample, or published description. The essential oil seems worthy of a more extended use than it has hitherto met with. When we take into consideration that competent authorities credit it with the chief, if not the only, power of the balsam, that its dose is only half the bulk, and that from the nature of the case there is greater probability of uniformity, the essential oil ought certainly to have so systematic a trial as should either result in its general adoption, or prove it not to be *the* active principle of the drug.

Either the balsam or the oil may be satisfactorily emulsified by rubbing in a mortar with its own weight of powdered gum-acacia, then adding water in the proportion of 2 parts to 1 of the gum used, and rubbing actively till a smooth, white, creamy emulsion is produced, after which more water may be added to give the required bulk; and then any other medicines that it may be desired to administer along with the copaiba.

ESSENTIAL OILS.

There are few cases in which essential oils are prescribed which require any pharmaceutical skill for their dispensing, turpentine as an anthelmintic, juniper as a diuretic, santal as a venereal remedy, and some of the pine oils as inhalations, being the most important. The instructions of the Pharmacopœia of the Throat Hospital for the making of inhalations, are to mix 2 drachms of the essential oils, and 1 drachm of light carbonate of magnesia, with water enough to make 3 fl. oz., the object of the magnesia being to keep the oil so divided gravity to about that of water, the starch requires to be used in a threefold proportion; that is, 3 drachms of starch to 2 drachms of the oil and 3 oz. of water. Under these circumstances the starch settles slowly, but when once settled, does not shake up again so readily as the carbonate of magnesia. Clay settles more readily in the presence of the essential oil than in pure water, but when settled, shakes up readily.

Many other absorbent powders might be used if there were occasion to vary the composition, but for purposes of inhalation no advantage could be expected from any change, as the light carbonate effects everything that can be desired of it, and, indeed, it might be used for the internal administration of essential oils generally. Oils of juniper, turpentine, &c., may be made into convenient draughts or mixtures by the same methods, and it would very rarely occur that the light carbonate of magnesia would be inappropriate therapeutically in the quantity required. Hitherto it has been more common to prescribe these latter, and any other oils given in doses of more than a few drops, in the form of emulsions. Most, if not all, can be conveniently emulsified as directed under the head of Balsam and Oil of Copaiba.

The use of magnesia to aid the suspension of resinous or oily matters is often convenient. Tincture of tolu, and simple tincture of guaiacum, when diluted with water in a mixture, are apt to deposit their resins on the side of the bottle, or in clots which cannot be shaken up into a takable condition. The presence of almost any finely-divided matter in suspension in the water helps the suspension of the resin, by attracting the liberated particles at the moment of precipitation, and preventing their adhesion into masses. The addition of 10 grains of carbonate of magnesia, heavy or light, to a drachm of tincture of guaiacum, permits of its dilution with an ounce of water without the agglomeration of the resin. Various other resinous tinctures, which at times give trouble by precipitation of their resin in an adhesive form, cease to present that annoyance in the presence of insoluble powders.

The mixture formed in this way is not so perfect as that which may be obtained with gum as an emulsion, and when a good emulsion is formed with gum and an oil, the addition of magnesia, &c., tends to its injury.

Liquid extract of male fern may be readily emulsified by rubbing with an equal bulk of solution of potash, and then adding 2 or 3 volumes of mucilage of acacia, and finally 15 to 20 volumes of water. An equally good emulsion may be made without the alkali, but it requires more patient rubbing. The extract being rubbed with its own weight of powdered acacia till thoroughly mixed; then, 3 parts of water being added, the rubbing is to be repeated till thorough mixing is again effected; and finally the remaining water which is required to give the desired bulk and fluidity. In place of a drachm of solution of potash, a scruple of soft soap and a drachm of water may be used, with very satisfactory results.

LECTURE XXX.

PHARMACY OF SPECIAL DRUGS: IODINE, SULPHUR, PHOSPHORUS, MERCURY, BISMUTH.

IODINE AND ITS COMPOUNDS.

MOST of the official iodides are satisfactory as regards uniformity and permanence, the exceptions being the iodide of iron and green iodide of mercury, the former of which it is scarcely practicable to keep in satisfactory condition in the crystalline or fused state, but which may be preserved quite well in solution in contact with an iron wire, and preserved in small bulks, so that when the bottle is once opened it may be promptly used,—exclusion of the air being all that is necessary to prevent change beyond a very minute oxidation, and that is provided against by the iron wire which maintains the solution in the ferrous condition, the absorbed oxygen derived from the air in the neck of the bottle being deposited as ferric oxide, which should be filtered out at the time of using. This change takes place more slowly in the presence of sugar; but the use of an iron wire in a bottle of syrup is not convenient, the viscosity of the liquid, which is probably one source of its slowness to oxidation, being an obstacle to the reduction of an oxidized solution, or to the separation of a deposited ferric oxide. When the syrup is prepared it should be preserved in small, well-corked bottles, so that it may be put into the hands of the patient in a condition as little oxidized as possible. Even under these circumstances patients often fancy the new supply is different

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from that which they have just finished, the yellow colour of the latter having developed without notice during the course of taking the supply.

The green iodide of mercury is frequently met with contaminated with the yellow iodide, and there are few occasions when it would not be at least equally appropriate to prescribe calomel and iodide of potassium.

The other iodides are definite, permanent, reliable, and tractable, presenting no difficulty to either prescriber or dispenser.

There have been several iodine compounds unofficially introduced into medical practice which demand a passing notice.

Free iodine, either in the form of liniment or ointment, causes an unpleasant harshness and discoloration of the skin, effects which it has been sought to obviate by the use of so-called colourless tincture of iodine, the object being to form a colourless combination of iodine more active than iodide of potassium. The object is attained by having part of the iodine combined with oxygen, and a corresponding portion combined with potassium, so that, in the presence of an acid, both portions of iodine are liberated, while the potassium and the oxygen unite with the acid to form a potash salt. For the development of this change, the added, taking care that the quantity dissolved be not in excess of that required. It is not impossible that under some circumstances iodine gradually liberated by the action of acid secretions upon a compound of this kind, may be more therapeutically active than that which is applied in the free state. Tincture of iodine mixed with carbolic acid does not show any prompt action, but if the carbolic acid be mixed with the decolourized tincture, and then sulphuric acid added in quantity sufficient to neutralize the potash present, the iodine, instead of being set free, attacks the carbolic acid and probably also the spirit, so as to produce a light brown solution with but little odour of either iodine or carbolic acid—a compound liquor probably resembling that known in pharmacy under the barbarous title of carbolate of iodine.

Iodized lint and cotton wool have been suggested as affording a simple mode of obtaining the gradual and continuous action of iodine locally. They may either be prepared by dipping the absorbent material in a solution of iodine in spirit, the strength of the ordinary tincture or of the liniment, according to the desire for a mild or strong iodization, passing them through an india-rubber mangle, and exposing to the air till the spirit has evaporated. I have found but little demand for such materials, and cannot speak of their action, but it has surprised me how long the lint thus prepared has retained its odour of iodine. Some I have had about six years folded in gutta-percha tissue has rotted the tissue, but still retains its dark brown colour and some odour of iodine. It only slowly loses colour exposed to the air at water-bath heat, but promptly becomes white under the action of caustic potash or hyposulphite of soda.

The internal administration of iodine in a form possessing much of the constitutional effects of free iodine in a moderated degree, but without the physiological effects of the bases with which it is commonly combined, has been attempted by combining the iodine with starch, tannin, or some other organic matters. The gradual liberation of the iodine from

its state of combination as the organic material underg
digestion, is supposed to introduce it into the system w
less irritation than results from the use of the iodine in
uncombined state; but these compounds can scarcely
regarded as having an established utility, or as havi
theoretical recommendations sufficiently strong and clear
justify the substitution of compounds wanting the reliabil
and definiteness of pure chemicals. As there are seve
preparations known under the name of iodide of starch, it
incumbent upon the prescriber to indicate clearly by wh
formula he intends the iodide to be prepared, and to wat
closely the effects upon the patient. The same objecti
applies to the "Sirop iodotannique," of which there a
several formulæ published, containing different proportic
of iodine, and probably most of it converted into hydrio
acid by the reducing action of the tannin.

SULPHUR.

For internal use, sulphur is most frequently given in t
form of electuary. Its bulky dose, its insipidity, and
reluctance to make a satisfactory mixture with water,
tend to the adoption of this form of administration; b

is no difficulty in effecting the mixture, and no tendency of the sulphur to separate and come to the surface so long as these fluids are not diluted, this disposition is developed on diluting them freely with water. Boiling the sulphur with water is the most effectual mode of overcoming this property, and enables a satisfactory mixture to be made. Another expedient is to adopt roll sulphur, and powder it under water. In this case a small portion persistently rises to the surface of the water; it probably consists of that part which, having been the outside of the mass, has attached to it a film of adhering air, while all those particles which have occupied the interior of the mass, and been exposed to water only, have no tendency to float, because of the absence of the film of air which there has been no opportunity of becoming attached to their surface. The tendency to float makes its appearance again, of course, if the sulphur be allowed to become dry. This explanation naturally suggests itself from the nature of the phenomena just detailed, but it must be admitted that it is not perfect; perhaps we may suggest that there is a want of molecular harmony between the sulphur and water which renders their attachment to one another so remarkably feeble. There may be supposed to be a similar want of harmony between oil and water, and it is worthy of remark that gum-acacia, which has such a notable power of emulsifying oil and water, has an equally notable power of inducing the mixture of sulphur with water. A mixture much resembling an emulsion may be made by rubbing ½ oz. of precipitated sulphur with 1 oz. of mucilage of acacia, and water sufficient to make 8 oz. The German compound liquorice powder,*

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* *Compound Liquorice Powder* (*Ph. Germ.*)

Take of—

Powdered senna leaves	12 oz.
„ liquorice root	12 oz.
„ fennel seed	6 oz.
Sulphur	6 oz.
Powdered sugar	36 oz.

Mix all together.

which contains one-tenth of its weight of sulphur, do not show this peculiarity, which is overcome by the bulk the accompanying materials. A small quantity of senna other mucilaginous matter is more efficacious in giving miscibility to sulphur than a larger proportion of sugar. The action of gum in facilitating the suspension of powders in water is commonly attributed to the viscosity which its presence produces, but that is no explanation of the action which it has in getting rid of the floating tendency of sulphur, and is only an obscure explanation of the power which it possesses of promoting the passage of a fine precipitate through a paper filter. Probably the mucous fluids of the stomach aid the absorption of finely-divided, insoluble powders by facilitating their passage through the tissues. It is remarkable how much chalk will pass through ordinary filtering paper if an ounce of it be rubbed into a smooth, creamy condition with mucilage of acacia, and then diluted with a pint of water, and how comparatively small a quantity will pass through a similar paper if the chalk be rubbed with water without the gum. We might anticipate an increased activity of insoluble powders by having them in this condition of suspension, were it not that the animal mucus probably

l solutions as required. The official phosphorated
ably as good a form as can be devised for keeping
as ready for dispensing in the liquid form; it keeps
l if bottled in small quantities, so as not to have the
ny times opened during the time its contents last.
e emulsified with acacia, or with almond powder
d to be given without further addition of oily
r it may be added to cod-liver oil, suitably in
e proportion of 10 minims to each ounce; in
e a half-ounce dose of the cod-liver oil will con-
f a grain of phosphorus.

ficial phosphorus pill does not seem to have given
tisfaction. It takes more time and trouble to make
uired for the dispensing of phosphorus by the method
on page 304, under Dispensing, and does not keep so
as to give confidence in the good condition of any
been long made. It was designed with the view
kept under water, and the insolubility in water,
onsidered advantageous from facilitating its protec-
nst the action of the air, has been viewed with
from its retarding the solution in the stomach.
ever, is not a serious objection, as the addition of
ther soluble matters to the mass at the time of
to pills facilitates its disintegration in the stomach.
orus mass, readily made, readily dispensed, and
or keeping either in an air-tight bottle or under
y be obtained by the following formula:—

f—

Phosphorus	5 gr.
White clay, in powder,	
Cacao butter . . .	āā 1 dr.
Lard	25 gr.
Sulphide of carbon . . .	½ dr.

phosphorus and sulphide of carbon into a mortar,
on as the former is dissolved add the clay; mix
nd before the sulphide has had time to evaporate

add the cacao butter, and continue the rubbing till the o of the sulphide has passed off and that of phosphorus is d loped; then add the lard, and work into a mass which cont 1 grain of phosphorus in half a drachm. This is stro than convenient for dispensing as phosphorus pills wit additions, but not stronger than desirable if required giving along with quinine, iron, nux vomica, &c. dispensing as pure phosphorus pills, the quantity of p phorus would be conveniently reduced without altering quantities of the other ingredients; thus, taking 1 grai phosphorus, and dividing the mass into thirty-two pills, if required dose were $\frac{1}{32}$ of a grain, and so on.

If it were necessary to prescribe phosphorus in an aque mixture, the same mode of operating would provide the me Thus:—

Take of—

Phosphorus	1 gr.
Sulphide of carbon . . .	½ dr.
White clay, in powder . .	½ dr.
Mucilage of acacia . . .	4 dr.
Water, to	4 oz.

The phosphorus being dissolved in the mortar, and the c rubbed with the solution, the mucilage added before when quite freshly prepared, there does not seem any reason for supposing that finely-divided mercury is not the essential and only legitimate source of activity.

Grey powder has been many times examined, and generally with the result that there is sufficient oxide present to add greatly to its medicinal effect, and not unfrequently to give it a violence of action quite objectionable.

Theoretically, blue pill and grey powder, both being essentially finely-divided mercury, should be nearly, if not quite, identical in effect; yet I have known practitioners express strong objection to giving a child blue pill, when they would not hesitate to give to the same patient a few grains of grey powder or a little calomel. Much of this feeling is simply an effect of custom or habit, and though the propriety of the administration of one drug or another is a problem the solution of which belongs to medical men only, the chemist or pharmacist cannot do otherwise than consider the theoretical merits of the two preparations, and urge upon the attention of the medical profession, when opportunity offers, the facts which are undeniable and the arguments which are strong in favour of giving the preference to blue pill whenever practicable. If finely-divided mercury be the desired remedy, it is more reliably attained by the use of blue pill. If an oxidized mercury be desired, the grey powder is not a reliable mode of its production. My own observation confirms the impression that blue pill is milder and more uniform than the grey powder of commerce in its action; and my analyses confirm those of others that the grey powder contains variable proportions of the mercury in a state of grey oxide, and not uncommonly traces, and in some cases palpable quantities, of the mercury in the state of its higher and poisonous oxide. While this unsatisfactory mercurial continues official—and that will probably be for long to come—the pharmacist's duty is to make frequent examinations of his samples if he purchases them ready made, which is the common custom in consequence of the troublesome length of the process when performed by hand, and the difficulty producing a product which looks so well as that made on th manufacturing scale by machinery. The Pharmacopœ directs that the grey powder should be prepared by rubbi together the chalk and mercury in a *porcelain mortar* un metallic globules cease to be visible *to the naked eye.*

If these instructions be literally obeyed there is little fe of the mercury undergoing more than the requisite degree comminution, and consequently less fear of oxidation. has been suggested to use sugar, or sugar of milk, instead the whole or part of the chalk, but it is not found that sug in the dry state has any protecting power over the mercur The greater stability of blue pill is consequent upon physical condition—its comparative imperviousness to air. should rather seek to facilitate the extinction of the mercur so as to remove as far as practicable the temptation to bu machine-made grey powder, and to inculcate the cessation the trituration so soon as the mercury ceases to be visible t the naked eye. It has been suggested to make the grey powder by putting the mercury and chalk into a bottle and shaking them together, a process which it appears to me is a more rapid way of obtaining the first division of the mercury, but which does not more readily effect its complete extinction. Other operators have thought advantage was found in having cury and chalk in the dry state, and fails to accomplish the final extinction which is the only point of difficulty. A more effectual, indeed a perfectly effectual, way of overcoming the difficulty of dividing the mercury, is to destroy its fluidity by amalgamation. Most of the familiar metals would be inadmissible for this purpose on account of their physiological activity, but three which I have tried with success, as far as regards physical requirements, are also probably quite unobjectionable in a therapeutic point of view. Mercury, 100 parts, amalgamated with 30 to 40 parts of bismuth, with 1½ parts of sodium, or with 1 of magnesium, so far loses its fluidity that it can be rubbed with 200 grains of chalk into a smooth grey powder, with no more trouble than it would take to rub the chalk into a smooth grey powder with any dark-coloured material, such as a few grains of lamp-black. The fact is, the mercury ceases to be visible to the naked eye before the knots of chalk cease to show as white specks. The presence of one-third of a grain of bismuth in a 3-grain grey powder could scarcely be objectionable, still less so the presence of $\frac{1}{200}$ grain of sodium or $\frac{1}{300}$ grain of magnesium. These two latter metals would no doubt be converted into soda and magnesia by keeping, or immediately on contact with water. On the other hand, having thus overcome the difficulty of preparing "home-made" grey powder, the question arises, Have we not produced an article which will be open to the same objections as apply to that made by machinery? Probably the only safe grey powder for long keeping would be such as most pharmacists would condemn as badly made, and the only advantage gained by the adoption of the process indicated above would be the facility it affords for the user making a little as he wants it, and knowing how old or new his stock may be. That is perhaps all that can be hoped for in a preparation of this nature. I should rather look upon a finely-divided mercury in a pulverulent form as essentially objectionable, and the entire removal of which from our list of therapeutic agents a thing to be desired, on the ground of its being incapable accurate definition, and unreliable as regards the degree of i activity. Any one disposed to try the experiment of makin grey powder with the aid of any of the three metals abo named, will find the magnesium slow to amalgamate, b expedited by heating the required quantity with the mercu in a test tube or flask. On the other hand, if he uses sodiu the union with mercury, which at first may be reluctant begin, is apt to develope almost explosive violence. It is bes to use a bulk of mercury and add the sodium in small fragments, allowing one to exhaust the violence of its actio before adding the next, and when the required quantity ha been added to keep the amalgam in a bottle protected fro the air and occasionally shaken, till the amalgam has change from a knotty condition to that of a smooth paste. Either o these two latter amalgams effervesces in water from evolutio of hydrogen, and undergoes oxidation more gradually in air the more electro-positive metal becoming oxidized and setting the mercury free in its fluid form.

If it were desired to facilitate the making of mercurial ointment or blue pill, the magnesium amalgam could be used with greater advantage than that made with sodium, as the latter allows the mercury to resume its fluid condition rather too quickly for convenience of thorough mixing. The amalcedure commonly adopted is to take 10 parts of yellow oxide of mercury, and heat it with oleic acid till dissolved, and then make up the total weight to 100 with any of the petroleum fats, and designate the result as 10 per cent. oleate of mercury. A more satisfactory process is to decompose perchloride of mercury in solution in hot water with a solution of oleate of soda, and make up the weight of the precipitate with petroleum fat, so that the 100 parts of product may contain 10 of peroxide of mercury. A good working formula is as follows:—

Take of—

Perchloride of mercury . .	4 oz.
Dry oleate of soda . . .	14 oz., or q.s.

Dissolve separately in hot water, mix the solutions, collect the precipitate on a calico strainer, wash with water, and, after draining, melt the precipitate with as much petroleum fat as makes up the weight to 32 oz.

The red and yellow oxides of mercury are identical in every respect except their state of division, and the red oxide is only fit for making ointments when it is so well powdered as to approach the yellow oxide prepared by precipitation, in its colour and smoothness. The retention of the old red precipitate is a consequence of habit and prejudice rather than reason or experience, and might be discontinued with advantage.

BISMUTH.

The compounds of bismuth in use in medicine are not numerous, and probably have not much difference in therapeutic value. The white bismuth, which is now officially a subnitrate, but which formerly was either a subnitrate or an oxychloride, is probably the least advantageous of the basic compounds as regards physical condition or chemical constancy; it is always heavy, sometimes granular, or minutely crystalline, and rather difficult to retain in suspension without considerable addition of gum. The official carbonate is m lighter, and in so far more convenient. The official liq of bismuth is of course free from this physical objection, has an unpleasant metallic taste. It has been felt to b desideratum to have a bismuth preparation smooth, tastel and well suspended. The French have such under the na of Quesneville's Cream of Bismuth, which consists of fresh precipitated subnitrate washed but not dried, and mixed w syrup of gum. English nostrums have also been introdu under the name of Lac. Bismuthi, probably prepared u similar principles. So far as my experience goes, the b bismuth compounds for this preparation are the oxychlori or the hydrated oxide, either of which makes a good, milk looking liquor when rubbed with gum and water in th proportion of 1 drachm of the bismuth compound, 2 drachm of mucilage of acacia, and water to make 1 oz. It is bette though not essential, that the bismuth precipitate be used i its undried state. Under any circumstances a partial subsidence takes place, but the supernatant liquid remains milky i appearance, and the sediment readily shakes up. To mak the "Lac. Bismuthi" from the moist precipitate, 1 oz. of th official white bismuth may be dissolved with the aid of heat i

LECTURE XXXI.

PHARMACY OF SPECIAL DRUGS: IRON.

In studying the pharmacy of iron and its compounds, the chief objects to be attained are the selection of such compounds as possess full therapeutic activity; they should also be readily obtainable in a state of purity, little liable to change by keeping, and should include such iron compounds as admit of being administered in mixture with any other drug that may be necessarily given at the same time. It is desirable to have preparations of iron suitable for giving along with acids, others for union with alkaline salts. At other times it may be desirable to give iron with iodide of potassium, or arsenical solutions; to use it in combination with astringent matters, or to have the iron-preparation itself as free from astringent properties as possible; and in all these varying circumstances something may be done towards getting satisfactory results, by studying and classifying the iron compounds and their reactions. There appears to be a great deal of speculation—groundless speculation, I believe I might say—regarding the advantages of iron in one form or other. The iron probably acts much in the same manner, and probably much in the same degree, in whatever form it be given, provided it is soluble; the difference observed depending upon the action of the acid or other body which imparts lubility, and the other substances which may be administered t the same time. The stomach is a great leveller; citrates, acetates, malates, or tartrates alike yield to its action; and the iron in combination with them probably acts just the same, whatever the organic compound may be.

The iron pharmaceuticals may be said to be liable to accidental impurity, but not to adulteration, the cheapness of the raw material being a protection against the temptation to wilful admixture, but affording no safety against carelessness of manipulation. The official processes generally provide satisfactory precautions, but at more than necessary cost of labour or material, and manufacturers frequently obtain equally good results by other means. The granular sulphate of iron is cheap, pure, and permanent. Perchloride of iron in solution is not readily prepared of an equal degree of purity by the official process, or by the older processes which it has supplanted; but the defects which occur either in that made according to the official formula or by dissolving hydrated peroxide of iron in hydrochloric acid, are not of such kind or degree as to affect its medicinal value, unless it is contaminated with unusual impurities, or is deficient in strength through carelessness with regard to the

lity of the chemicals used; but if so, this is the fault of

of the process.

excess of hydrochloric

impreg-

These three preparations may be considered to stand apart from all the other preparations of iron in respect to their superiority when we view them in all aspects—their well-established therapeutic value, the ease and certainty of their preparations, their permanence, and the readiness with which they meet the requirements of almost every combination in which it is desirable to administer iron—their perfect solubility, and consequent ready absorption and uniform action.

Peroxide of iron, like the three preceding, is readily and cheaply obtained of good and uniform quality; but however good and uniform its composition may be, its action is not so reliable as that of the soluble compounds previously spoken of. The condition of the stomach of the patient will, in all probability, materially influence the activity of preparations of this class, which are only dissolved in the presence of acid. It has sometimes been administered in extravagant doses; but the effects obtained are not proportionate to the quantity given, but to the quantity which is absorbed into the circulation, and this in turn will be determined more by the quantity of acid in the stomach than by the bulk of the material taken; but it will be determined also to some extent by the physical condition of the oxide. If it is overheated and rendered anhydrous, it is almost inert.

Saccharated carbonate of iron is not of certain composition. Theoretically, it might be expected to be uniform; but though the materials used are so cheap as to put it beyond any temptation to prepare it otherwise than correctly, it is reported by those who have taken samples from actual use to be very variable. It probably does not possess any therapeutic superiority to compensate for this serious defect.

Mistura ferri composita may be regarded as superior to the saccharated carbonate of iron in constancy of composition, *if prepared at the time it is dispensed*, because in that case its quality as sent out is dependent only upon the quality of the sulphate of iron and carbonate of potash used in its preparation; but its rapid change of colour, though it may not be accompanied with an equal change in medicinal value, trouble to the pharmacist, and a source of uneasiness to patient from the impression which it is apt to leave that medicine spoils by keeping, or that the new supply is not t same as the old; but these little inconveniences are as nothi compared with its superiority in affording a definite do of almost pure carbonate of iron in suitable condition f taking. If carbonate of iron is therapeutically demanded, th appears to be the best form yet adopted for its administratio

Iodide of iron, including the pill and the syrup, may classed among the unsatisfactory preparations which ha given trouble to pharmacists for many years past, and do n appear to have accomplished anything commensurate wit the popularity they once possessed. They were introduc upon theoretical grounds. The idea of combining the ton action of iron with the alterative properties of an iodi appeared a happy thought; but experience does not seem have justified the great expectations, and the fashion whi prevailed only a few years ago is now yielding before t newer fashion of giving iron syrups in which phospho and lactic acids are supposed to develop new virtues in t old base.

Looking over the long list of iron preparations which have en introduced into practice on the authority of some fluential name, and in many cases also made official by one other of the British or foreign Pharmacopœias, we fail to tect any general principle which has guided their introducon. Comparing those which have been discarded with those hich have supplanted them in the official list, the change is mmonly for the better as regards uniformity of quality permanence; but this cannot be said to be characteristic the many new claimants for popularity, which have not en, and I hope will not be, admitted into the Pharmapœia.

We must next consider in what way a few of those which ve acquired a lasting reputation may in practice be comned with other drugs without involving deterioration or any jectionable decomposition, and, at the same time, allowing l the latitude which a prescriber may desire in the associaon of other therapeutic actions with the tonic effect of iron. his will necessarily include some consideration of what are mmonly denominated the incompatibles of the iron salts. e every now and then hear mixtures spoken of as unchemical hen there is no just ground for that imputation. It does t follow that a mixture is unchemical, or that its ingreents are incompatible when a decomposition takes place nongst them, unless the decomposition has been overlooked the prescriber, and results in a detraction from the efficacy the mixture, or the development of some unwished-for prorty. Some of the text-books say that vegetable astringents e incompatible with the iron salts, no doubt because they oduce with them a black, unpleasant-looking precipitate; it it may be that the inky-looking mixture is just as valule as if no change of appearance had taken place; the nnate of iron being advocated by Benedetti as a chalybeate pecially suited to chlorosis. The alkaline carbonates are so enumerated among the incompatibles of the sulphate and rchloride of iron, but the compound iron mixture of the

Pharmacopœia is strictly chemical, and contains these so-called incompatibles; and if we find tincture of iron and aromatic spirit of ammonia prescribed together, it could only be regarded as unsatisfactory if the decomposition had been overlooked by the prescriber, a point which it is often difficult for the dispenser to determine; the only cases in which it is desirable for the dispenser to question the correctness of the prescription are where one ingredient unmistakably defeats the object of another, or developes some source of danger. I have seen syrup of iodide of iron prescribed in conjunction with an alkaline carbonate, and, though I had no hesitation in concluding that it was an oversight, I also had no hesitation in dispensing the mixture as it was prescribed; the action would not be dangerous, and, indeed, would probably be much the same as if no decomposition had taken place; but when we find perchloride of iron prescribed together with iodide of potassium, the case is more serious—a decomposition ensues liberating iodine, the effect of which, even in small doses, is not to be trifled with. In one case which I have met with the decomposition had been overlooked by the prescriber; in another instance the change was understood, and the effect of the liberated iodine desiderated. Keeping these circumstances before us, it appears to be the duty of the pharmacist to dispense as prescribed all mixtures in which no d to illustrate the application of these facts, I have here a ries of mixtures :—

No. 1.

℞	Ferri sulph.,	
	Acid. tannic.	āā gr. x.
	Aquæ	℥iv.
M.		

Divide into four phials, A, B, C, and D.

A has received no addition, and you perceive the usual inky posit.

B contains 10 drops of dilute sulphuric acid, which has dissolved the precipitate, leaving the solution almost colour- s and clear, in consequence of the precipitation not taking ce in the presence of a small excess of a powerful acid.

C has a similar condition imparted by the addition of 10 ps of sulphurous acid, which acts as a reducing agent; the phate, which is entirely free from peroxide, yielding no cipitate with tannic acid, as may be shown by the power ulphuretted hydrogen or metallic iron to produce a similar lourization. The addition of an alkaline salt to a solution decolourized causes a dirty pink precipitate; exposure he air, by which oxidation takes place, causes a purple k coloration; consequently, this is not so satisfactory a e of preventing the colour as the use of a little free huric acid, an addition which would rarely be objection- when iron and astringent remedies were required.

contains three grains of sulphite of soda as an addition, h has increased the black or pinkish-black precipitate, onsequence of the soda taking the sulphuric acid and ng the iron in combination with a feebler acid, not ble of withstanding the precipitating power of the in.

No. 2.

℞	Tinct. ferri perchlor. . . .	ʒss.
	Acid. tannic.	gr. x.
	Aquæ, ad	℥ij.
M.		

Divide into two phials, A and B.

A, having received no addition, contains a black precipitate, the clear portion also being purple-black.

B, which has been rendered freely acid with half a drachm of diluted hydrochloric acid, is olive-green, and contains no deposit.

From these reactions I think we may conclude that, if *it is medically* desirable to administer iron with vegetable astringents, they may be regarded as chemically and pharmaceutically compatible in the presence of a little free mineral acid.

In actual practice we more frequently find that the astringent matter is incidental rather than an essential constituent of the mixture, and is present in comparatively small proportion. Infusion of gentian or of roses, tincture of cardamoms or of orange peel, being among the most frequent sources of the astringent principle, the blackening which takes place in consequence of their presence is, under any circumstances, less offensive than in the neutral mixtures described above.

The series of phials marked 2 C, 2 D, 2 E, 2 F, show the behaviour of compound tincture of cardamoms in such mixtures.

No. 2 C.

℞ Ferri sulph. . . . . gr. v.

of the four. With the perchloride, the colour, which is at first greenish-black, becomes brown in the course of a day or two.

The next requirement is to provide suitable forms for the administration of iron in company with alkalies or alkaline salts. In the chemical handbooks it is stated that alkalies fail to precipitate iron in the presence of fixed organic substances, such as sugar or tartaric acid. This indicates the principle upon which our present object is to be attained, but it is necessary in the first place to note that in medicine and pharmacy carbonates of soda or potash are commonly spoken of as alkalies, but in chemical language the term alkali is restricted to the hydrates uncombined with carbonic or any other acid; and also to note that the completeness of the action must of necessity depend upon the proportion which subsists between the three substances—the iron salt, the organic matter, and the alkali.

With a given quantity of iron salt, one proportion of sugar will completely prevent its precipitation, while a smaller proportion will only prevent its being completely precipitated.

When it is desired to prescribe an iron salt with an alkaline carbonate, the carbonate of iron, in the form of compound iron mixture, and the citrate of iron and ammonia, are quite appropriate, and probably leave nothing to be desired; but as we meet with cases such as those previously alluded to, we may advantageously give them a passing comment.

In the prescription where tincture of perchloride of iron was ordered along with aromatic spirit of ammonia, a comparatively elegant mixture might have been produced if a little syrup had been added. Thus—

No. 3.

℞	Tinct. ferri perchlor. . . .	ʒss.
	Syr. simpl.	ʒij.
	Aquæ	ʒx.
	Misce et adde	
	Spir. ammon. ar.	℥ss.

This, you will observe by the sample on the table, retains most of the iron in solution. It would have retained all if ammonia and not its carbonate had been added; and it would have retained *none*, or next to none, if the aromatic spirit of ammonia had been mixed with the tincture of iron before the addition of the syrup, as is exemplified in the bottle marked No. 3 B, which contains the same ingredients mixed in a different order. In this case almost the whole of the iron has gone down as peroxide, the supernatant liquor being colourless.

In the bottle marked No. 4 there is the following mixture:—

No. 4.

℞	Tinct. ferri perchlor.	ʒss.
	Syr. simpl.	ʒij.
	Aquæ, ad	℥ij.
	Potass. bicarb.	ʒss.
M.		

And in No. 4 B there is the same mixture, substituting 3 drachms of solution of potash for the 30 grains of bicarbonate. In this case you will observe the sugar retains the iron in solution in the presence of caustic alkali, but not in the presence of the bicarbonate.

No. 4 C.

℞	Sodæ tartaratæ	ʒij.
	Aquæ	℥iss.

No. 4 D.

℞	Tinct. ferri perchlor.	♏ xv.
	Liq. ammon. acet.	ʒij.
	Aquæ, ad	℥ij.

M.

he perchloride of iron is converted into peracetate, as is lent from the rich deep colour developed; the diuretic on of the acetate of ammonia is diminished by the con- ion of a portion of it into chloride of ammonia.

n No. 5 we illustrate the behaviour of the proto-salt under lar circumstances, the mixture being as follows:—

No. 5.

℞	Ferri sulph.	gr. viij.
	Syr. simpl.	℥ss.
	Aquæ	℥ss.
	Potass. bicarb.	gr. xx.

M.

in No. 5 B the same ingredients occur with 2 drachms lution of potash in the place of 20 grains of bicarbonate. he former is an unpleasant-looking puddle, the latter a green solution almost free from sediment; it gradually rs darker by oxidation, eventually becoming a clear dark n liquor.

No. 5 C.

℞	Syr. ferri iodid.	ʒj.
	Aquæ	ʒvss.
	Liq. potassæ	ʒjss.

M.

his is designed to show that the mixture, which I before ribed as having an unpleasant appearance from bicar- te of potash being ordered along with syrup of iodide of might have claimed a place amongst the preparations of ant pharmacy by the simple substitution of an equivalent ustic potash in place of the bicarbonate. It thus forms rk green mixture free from sediment, and rather pretty ppearance.

is perhaps self-evident that when iron is to be used with oxidizing agents, it should be in the peroxidized condition. The four following formulæ illustrate that proposition:—

No. 6.

℞	Tinct. ferri perchlor.	ʒss.
	Potassæ chloratis	ʒss.
	Aquæ	℥ij.
M.		

No. 7.

℞	Ferri sulph.	gr. x.
	Potassæ chloratis	ʒss.
	Aquæ	℥ij.
M.		

No. 8.

℞	Ferri sulph.	gr. x.
	Acid. nitr. hydrochlor. dil. . .	ʒj.
	Aquæ	℥j.
M.		

No. 9.

℞	Ferri sulph.	gr. x.
	Acid. nitr. dil.	ʒj.
	Aquæ	℥j.
M.		

In No. 6 there is no evident change; possibly there may b a partial decomposition, but not a total interchange of acid and bases, for when a hot saturated solution of chlorate of

No. 11.

℞	Tinct. ferri perchlor.	ʒj.
	Potassii bromidi	ʒj.
	Aquæ, ad	℥j.
M.		

No. 12.

℞	Ferri et ammonii citr.	ʒss.
	Potassii iodidi	ʒss.
	Aquæ, ad	℥j.
M.		

ey are all mixtures which have occurred in actual dis-
ng, the first being of a rather dangerous character.

e iron yields up its one and a half equivalents of chlorine
vour of one equivalent of iodine which it takes from one
alent of iodide of potassium. There is thus half an
alent of chlorine set free, which in turn combines with
sh portion of potassium, setting free iodine, neither the
nor the potassium having the power of combining with
e than a single equivalent of iodine. Before the ingre-
ts were mixed, there was neither free chlorine nor iodine,
none of them could be considered dangerous; after they
mixed iodine is set free, and danger is developed. The
k red-brown colour and characteristic odour may be
rded as sufficient evidence of the free iodine, the presence
hich may be made still more clear by agitating a little
he mixture with sulphide of carbon, which takes the
ne from the aqueous solution, and acquires a beautiful
t colour, like the vapour of iodine.

medical friend, who had been made aware of this decom-
tion in the case of iodide of potassium, recently asked me
e would be safe in prescribing bromide of potassium in
n with perchloride of iron. I replied in the affirmative,
ting to the fact that iron is capable of forming a sesqui-
nide, and the mixture was made similar to No. 11. The
iderable increase in the depth of colour which took place
dding the bromide (which was added last) so far shook
confidence in my previously expressed opinion, that I
ght it desirable to test the mixture with sulphide of

carbon; but, as you see by the mixture I now make, there is no free bromine, or the sulphide would have become coloured yellow.

We also observe that the sulphide subsides to the bottom of the mixture No. 12 without becoming tinted, from which we learn that citrate of iron and ammonia affords us a suitable form for the administration of iron in connection with iodide of potassium.

Nos. 13, 14, and 15 exemplify the administration of iron salts with arsenic.

No. 13.

℞	Tinct. ferri perchlor.	ʒss.
	Liq. arsenici hydrochlor.	gtt. xv.
	Aquæ	℥j.
M.		

No. 14.

℞	Tinct. ferri perchlor.	ʒss.
	Liq. arsenicalis	gtt. xv.
	Aquæ	℥j.
M.		

No. 15.

℞	Ferri et ammon. citr.	gr. v.
	Liq. arsenicalis	gtt. v.
	Aquæ	℥j.
M.		

The British Pharmacopœia arseniate of iron contains too little iron in a dose to be considered possessed of chalybeate porizing of the required product, rather than such formulæ as are too complicated or tedious to be thus used, and so involve the making of an article which deteriorates by keeping; thus, if carbonate of iron be required, the "mist. ferri comp." is to be preferred to ferri carbonas saccharata.

That the old, simple, well-tried, and permanent preparations of iron, if judiciously managed, are capable of meeting the requirements of very diverse circumstances.

That if the physician and the chemist consult together, any difficulties of prescribing and dispensing are easily overcome; and that true progress in the pharmacy of iron will be best promoted by the physician pointing out what objections he finds in any of the established preparations, and indicating what desiderata are to be sought in the devising of new forms, and by his refusing to countenance preparations which are introduced without good evidence of their at least *seeking to attain* these objects; and the pharmacist's duty in this respect is to confine his attention to the chemistry and pharmacy of the subject in endeavouring to accomplish those objects which medical knowledge has shown to be desirable.

Such division of labour, and such harmonious working between the members of our calling and the members of the medical profession, cannot fail to be among the first-fruits of that higher pharmaceutical education which it has long been my habit to inculcate, and my desire to promote.

APPENDIX I.

MEDICINAL LOZENGES.

B.P. strengths.

	In each.		In eac
Acid tannic . . .	$\frac{1}{2}$ grain	Morphia hydrochl. . .	$\frac{1}{36}$ gr
White bismuth. . .	2 grains	Morph. and ipecac. .	$\frac{1}{36}$ and $\frac{1}{12}$ gr
(With carb. magnesia and chalk.)		Opium extract . . .	$\frac{1}{10}$ gr
Catechu	1 grain	Potash chlorate. . .	5 gr
Reduced iron . . .	1 grain	Soda bicarbonate . .	5 gr
Ipecacuanha . . .	$\frac{1}{4}$ grain		

The pharmacopœial dose is in all cases 1 to 6 lozenges, b this must be regarded as a rough statement only. The a vantage of this form of administering remedies is the facili it affords for small, frequently-repeated doses. The do would be more conveniently fixed in relation to the numb it is desirable to take in the course of twenty-four hou Thus, for the morphia lozenges it would be more appropria to instruct a patient to take one or two at a time, not mo than twelve in twenty-four hours. The local action is thus mo e following table gives the Throat Hospital lozenges and pastils with strengths, doses, and actions :—

Name.	Mark.	Strength.	1 Lozenge every	Use.
h. acid. benzoici .	B.A.	½ gr.	4 hours	Voice lozenge, and valuable stimulant in nervo-muscular weakness of throat.
,, carbolici .	C.A.	1 gr.	4 hours	Antiseptic and stimulant
,, tannici .	T.	1¼ gr.	3 ,,	Strongly astringent.
aconiti . .	A.C.	½ min. tinct.	½ or 1 hour	In tonsillitis and febrile affections of the throat
althææ . .	...	$1\frac{1}{7}$ gr.	½ hour	Emollient.
ammon. chlor. .	M.A.	2 gr.	3 hours	In congestion of pharynx and larynx.
boracis . .	B.O.	3 gr.	3 or 4 hours	Mildly detergent; useful in thrush and muscular weakness of the throat.
catechu . .	C.T.	2 gr.	3 ,,	Astringent; less powerful than tannin.
cubebæ . .	C.B.	$\frac{4}{7}$ gr.	3 ,,	To diminish excessive secretion.
guaiaci . .	G.	2 gr.	2 ,,	Specific for crescent inflammation of tonsils, useful in acute and sub-acute inflammation of the throat.
hæmatoxyli. .	L.W.	2 gr.	3 ,,	Mildly astringent.
kino . . .	K.	2 gr.	3 ,,	Astringent; rather less powerful than krameria.
krameriæ . .	R.	3 gr.	3 ,,	Very useful astringent; does not disagree with the stomach or cause constipation.
lactucæ . .	L.	1 gr.	1 hour	Soothing; mildly sedative.
potass. chloratis .	P.	3 gr.	3 hours	Stimulant and antiseptic for thrush and aphthous ulceration.
,, citratis .	C.P.	3 gr.	3 ,,	Topical sialogogue.
,, tartratis acidæ	T.P.	3 gr.	3 ,,	Topical sialogogue.
pyrethri . .	P.Y.	1 gr.	3 ,,	Very valuable sialogogue.
sedativi . .	S.	$\frac{1}{10}$ gr. ext. opii	3 ,,	Sedative for irritability or pain.
Li acidi boracici .	...	2 gr.	3 ,,	In aphthous affections of the mouth and throat.
,, carbolici .	...	½ gr.	,,	Antiseptic and stimulant.
ammon. chloridi .	...	2 gr.	1 hour	In chronic pharyngeal catarrh.
bismuthi . .	...	3 gr.	2 or 3 hours	In congestion of the pharynx with insufficient secretion.
bismuthi et . . potass. chlor. .	... ...	3 gr. 2 gr.	1 to 2 hours	In granular pharyngitis with follicular ulceration of the tonsils, and in aphthæ of the mouth.
iodoformi . .	...	1 gr.	3 ,,	In chronic pharyngitis and syphilitic eruptions of the tongue, mouth, and throat.

ections for Use.—Allow the lozenge or pastil to dissolve passively in outh, and fluids should not be taken for a short time afterwards.

APPENDIX II.

PHARMACEUTICAL SPECIFIC GRAVITIES.

The following table indicates the specific gravities of various pharmaceuticals as defined in the B.P. :—

Acetum . .	1017 to 1019	Liquor calcis saccharatus	. 1052
Acidum aceticum . .	. 1044	,, chlori . . .	. 1003
,, ,, dilutum	. 1006	,, ferri perchlor. fort.	. 1440
,, ,, glaciale	. 1065	,, ,, pernitratis .	. 1107
,, carbolicum .	. 1065	,, ,, persulphatis.	. 1441
,, hydrochloricum .	. 1160	,, hydrarg. nitr. acid.	. 2246
,, ,, dilutum.	1052	,, plumbi subacetatis	. 1260
,, hydrocyanicum dil.	. 997	,, potassæ . .	. 1058
,, nitricum . .	. 1420	,, sodæ . . .	. 1047
,, ,, dilutum	. 1101	,, ,, chloratæ .	. 1103
,, nitr. hydrochl. dil.	. 1074	Oleum sinapis . .	. 1015
,, phosphoricum dil.	. 1080	Oxymel scillæ . .	. 1320
,, sulphuricum .	. 1843	Phosphorus . . .	. 1770
,, ,, aromat..	927	Spiritus ætheris nitrosi .	. 845

TABLE OF SPECIFIC GRAVITIES OF TINCTURES.

he column headed "Method" indicates by the letters M, aration; P, Pharmacopœia, and S, Stoddart's method as ribed in the *Pharmaceutical Journal* of September 14, . The other columns sufficiently explain themselves.

Name.	Method.	Grains per oz. of ingredients used.	Sp. g. of solvent.	Sp. gr. of tincture.	Total contents per oz. in grains.	Per cent. of ingredients dissolved.
Tinct. aconiti	M	54·68	·838	·8480	6·30	11·5
" "	P	54·68	·838	·8619	7·22	13·2
" "	S	54·68	·838	·8620	7·26	13·2
" arnicæ	M	21·87	·838	·8460	3·80	17·3
" "	P	21·87	·838	·8557	4·61	21·0
" "	S	21·87	·838	·8560	4·84	22·1
" aurantii	M	43·75	·920	·9380	14·50	33·1
" "	S	43·75	·920	·9410	17·00	38·8
" belladonnæ	M	21·87	·920	·9300	6·62	30·2
" "	P	21·87	·920	·9285	6·29	28·7
" "	S	21·87	·920	·9290	5·65	25·8
" buchu	M	54·68	·920	·9320	10·39	19·0
" "	P	54·68	·920	·9323	10·50	19·2
" "	S	54·68	·920	·9340	10·53	19·2
" calumbæ	M	54·68	·920	·9320	7·08	12·9
" "	P	54·68	·920	·9389	8·10	14·8
" "	S	54·68	·920	·9390	8·13	14·8
" capsici	M	16·40	·838	·8428	6·31	38·4
" "	P	16·40	·838	·8429	6·32	38·5
" "	S	16·40	·838	·8431	6·56	40·0
" card. co.	M	68·62	·920	·9552	30·40	44·3
" "	P	68·62	·920	·9550	29·11	42·4
" "	S	68·62	·920	·9530	28·54	41·6
" cascarillæ	M	54·68	·920	·9277	8·33	15·2
" "	P	54·68	·920	·9298	10·75	19·6
" "	S	54·68	·920	·9305	10·87	19·9
" catechu	M	76·56	·920	·9649	43·52	56·8
" "	S	76·56	·920	·9700	46·98	61·3
" chiratæ	M	54·68	·920	·9274	4·84	8·8
" "	P	54·68	·920	·9278	5·83	10·6
" "	S	54·68	·920	·9280	5·99	10·9
" cinch. co.	M	81·00	·920	·9402	20·99	25·9
" "	P	81·00	·920	·9414	21·19	26·1
" "	S	81·00	·920	·9423	21·20	26·1
" cinch. flav.	M	87·50	·920	·9383	16·13	18·2
" "	P	87·50	·920	·9387	16·19	18·5
" "	S	87·50	·920	·9441	16·18	18·2
" cinnam.	M	54·68	·920	·9306	8·98	16·6
" "	P	54·68	·920	·9307	8·99	16·4
" "	S	54·68	·920	·9308	8·96	16·4
" colch. sem.	M	54·68	·920	·9263	5·11	9·3

No.	Name.	Method.	Grains per oz. of ingredients used.	Sp. gr. of solvent.	Sp. gr. of tincture.	Total contents per oz. in grains.
42	Tinct. colch. sem.	P	54·68	·920	·9284	5·34
43	,, ,,	S	54·68	·920	·9305	5·36
44	,, conii	M	54·68	·920	·9260	5·63
45	,, ,,	P	54·68	·920	·9280	6·33
46	,, ,,	S	54·68	·920	·9285	6·45
47	,, croci	M	21·87	·920	·9259	10·99
48	,, ,,	P	21·87	·920	·9281	15·08
49	,, ,,	S	21·87	·920	·9312	18·47
50	,, cubebæ	M	54·68	·838	·8448	10·10
51	,, ,,	P	54·68	·838	·8454	10·54
52	,, ,,	S	54·68	·838	·8460	10·65
53	,, digitalis	M	54·68	·920	·9375	8·98
54	,, ,,	P	54·68	·920	·9372	8·42
55	,, ,,	S	54·68	·920	·9389	8·36
56	,, ergotæ	M	109·37	·920	·9367	16·44
57	,, ,,	P	109·37	·920	·9366	16·27
58	,, ,,	S	109·37	·920	·9366	16·89
59	,, gallæ	M	54·68	·920	·9658	41·74
60	,, ,,	P	54·68	·920	·9632	36·13
61	,, ,,	S	54·68	·920	·9605	35·93
62	,, gent. co.	M	60·15	·920	·9430	23·70
63	,, ,,	P	60·15	·920	·9436	25·79
64	,, ,,	S	60·15	·920	·9438	25·85
65	,, hyoscy.	M	54·68	·920	·9290	15·30
66	,, ,,	P	54·68	·920	·9320	24·61
67	,, ,,	S	54·68	·920	·9323	24·97
68	,, jalapæ	M	54·68	·920	·9323	18·20
69	,, ,,	P	54·68	·920	·9324	18·24
70	,, ,,	S	54·68	·926	·9382	18·24
71	,, kramer.	M	54·68	·920	·9340	17·56
72	,, ,,	P	54·68	·920	·9371	17·88

Name.	Method.	Grains per oz. of ingredients used.	Sp. gr. of solvent.	Sp. gr. of tincture.	Total contents per oz. in grains.	Per cent. of ingredients dissolved.
Tinct. rhei	S	60·15	·920	·9386	29·01	48·2
,, sabinæ.	M	54·68	·920	·9890	12·94	23·6
,, ,,	P	54·68	·920	·9891	12·81	23·4
,, ,,	S	54·68	·920	·9896	12·87	23·5
,, scillæ	M	54·68	·920	·9516	43·02	78·6
,, ,,	P	54·68	·920	·9571	48·72	89·1
,, ,,	S	54·68	·920	·9680	48·80	89·2
,, senegæ	M	54·68	·920	·9351	18·05	33·0
,, ,,	P	54·68	·920	·9353	18·28	33·3
,, ,,	S	54·68	·920	·9356	18·26	33·3
,, sennæ	M	120·31	·920	·9616	41·47	34·4
,, ,,	P	120·31	·920	·9603	40·41	33·5
,, ,,	S	120·31	·920	·9670	40·65	33·7
,, serpent.	M	54·68	·920	·9233	6·00	10·9
,, ,,	P	54·68	·920	·9239	6·57	12·0
,, ,,	S	54·68	·920	·9241	6·57	12·0
,, stramonii	M	54·68	·920	·9317	2·86	5·0
,, ,,	P	54·68	·920	·9318	2·89	5·1
,, ,,	S	54·68	·920	·9318	2·89	5·1
,, sumbul	M	54·68	·920	·9246	16·25	29·7
,, ,,	P	54·68	·920	·9248	16·48	30·1
,, ,,	S	54·68	·920	·9243	15·70	28·7
,, valerian	M	54·68	·920	·9205	5·10	9·3
,, ,,	P	54·68	·920	·9215	6·10	11·1
,, ,,	S	54·68	·920	·9250	6·30	11·5
,, valer. co.	M	54·68	·870	·9000	5·03	9·1
,, ,,	S	54·68	·870	·9064	6·16	11·2
,, verat. virid.	M	87·50	·838	·8524	11·56	13·3
,, ,,	P	87·50	·838	·8527	12·72	14·5
,, ,,	S	87·50	·838	·8624	13·90	15·8
,, zingiber.	M	54·68	·838	·8425	2·17	3·9
,, ,,	P	54·68	·838	·8426	2·18	3·9
,, ,,	S	54·68	·838	·8428	2·21	4·0
,, zingib. fort.	P	218·75	·838	·8530	9·09	4·1
,, ,,	S	218·75	·838	·8533	9·14	4·1
Vin. colchici	M	87·50	·988	1·0033	*38·04	24·1
,, ,,	S	87·50	·988	1·0050	39·10	25·3
,, ipecac.	M	21·87	·988	·9946	26·16	42·1
,, ,,	S	21·87	·988	·9970	26·95	45·7
,, rhei	M	35·81	·988	1·0176	38·62	60·5
,, ,,	S	35·81	·988	1·0212	41·65	68·9
,, xericum	...	...	·988	...	16·95	...

*These determinations include the total contents per ounce of the wine.

Mr. Umney gives the following table of specific gravities which he obtained in liquors prepared by himself according to B.P. instructions, which yielded him results differing from those officially indicated:—

	B.P. sp. gr.	Sp. gr. found.
Acid. sulphurosum (9·2 per cent.)	1·040	1·048
Extr. cinchonæ liquidum	1·100	1·122
Liq. bismuthi	1·122	1·134
,, calcis chloratæ	1·035	1·050
,, ferri perchlor. fort	1·338	1·445
,, hydrarg. nitr. acidus	2·246	2·130
,, plumbi subacetatis	1·260	1·270
,, sodæ chloratæ	1·103	1·090
Syr. ferri iodidi	1·385	1·400
,, mori	1·330	1·298
,, papaveris	1·320	1·330
,, sennæ	1·310	1·320
Tinct. ferri perchloridi.	0·992	1·007

A further note of these specific gravities and the strengths of the liquors will be found in the *Pharmaceutical Journal*, November, 1872. In the same paper Mr. Umney gives the following table of specific gravities of liquors, of which densities have not been officially defined:—

Acet. scillæ	1·038	Spiritus armoraciæ comp.	·9[illegible]
Extr. filicis liquidum	1·000	,, camphoræ	·8[illegible]
Liq. ammoniæ acetatis	1·022	Syrupus aurantii	1·2[illegible]
,, ammoniæ citratis	1·062	ferri phosphatis	1·3[illegible]

APPENDIX III.

LEMENTS WITH THEIR SYMBOLS AND ATOMIC WEIGHTS.

Name.	Symbol.	Atomic Weight.		Combining capacity
		Old.	New.	
Aluminium	Al.	13·7	27·4	4
Antimony	Sb.	64·6	122·0	5
Arsenic	As.	37·7	75·0	5
Barium	Ba.	68·7	137·0	2
Bismuth	Bi.	213·0	210·0	5
Boron	B.	11·0	11·0	3
Bromine	Br.	78·4	80·0	1
Cadmium	Cd.	56·0	112·0	2
Cæsium	Cs.	...	133·0	1
Calcium	Ca.	20·0	40·0	2
Carbon	C.	6·0	12·0	4
Cerium	Ce.	46·0	92·0	4
Chlorine	Cl.	35·5	35·5	1
Chromium	Cr.	28·0	52·2	6
Cobalt.	Co.	29·5	58·8	4
Niobium, or Columbium	Nb.	185·0	94·0	5
Copper	Cu.	32·0	63·4	2
Didymium	Di.	...	95·0	2
Erbium	Eb.	...	112·6	2
Fluorine	F.	19·0	19·0	1
Glucinum	Gl.	...	9·4	2
Gold	Au.	199·0	197·0	3
Hydrogen	H.	1·0	1·0	1
Indium	In.	...	198·0	4
Iodine.	I.	127·0	127·0	1
Iridium	Ir.	99·0	198·0	4
Iron	Fe.	28·0	56·0	6
Lanthanum.	La.	...	93·6	2
Lead	Pb.	103·6	207·0	4
Lithium	Li.	7·0	7·0	1
Magnesium.	Mg.	12·0	24·0	2
Manganese	Mn.	27·7	55·0	6
Mercury	Hg.	200·0	200·0	2
Molybdenum	Mo.	48·0	96·0	6
Nickel.	Ni.	29·0	58·8	4
Nitrogen	N.	14·0	14·0	5
Osmium	Os.	99·7	199·2	6
Oxygen	O.	8·0	16·0	2
Palladium	Pd.	53·0	106·0	4

Name.	Symbol.	Atomic Weight.		Combini[illegible] capacity
		Old.	New.	
Phosphorus	P.	32·0	31·0	5
Platinum	Pt.	98·8	191·4	4
Potassium	K.	39·1	39·1	1
Rhodium	Rh.	52·2	104·4	4
Rubidium	Rb.	...	35·4	1
Ruthenium	Ru.	...	104·4	6
Selenium	Se.	39·6	79·4	6
Silicon	Si.	22·0	28·0	4
Silver	Ag.	108·0	108·0	1
Sodium	Na.	23·0	23·0	1
Strontium	Sr.	43·8	87·6	2
Sulphur	S.	16·0	32·0	6
Tantalum	Ta.	...	182·0	5
Tellurium	Te.	64·0	128·0	6
Thallium	Tl.	...	204·0	3
Thorinum	Th.	59·0	57·9	2
Tin	Sn.	59·0	118·0	4
Titanium	Ti.	24·3	50·0	4
Tungsten	W.	99·7	184·0	6
Uranium	U.	60·0	120·0	4
Vanadium	V.	68·5	51·2	5
Yttrium	Y.	32·0	61·6	2
Zinc	Zn.	32·0	65·2	...
Zirconium	Zr.	23·0	89·6	4

APPENDIX IV.

LE OF CHEMICAL FORMULÆ AND SOLUBILITIES OF PHARMACEUTICAL BODIES.

following table has been compiled from information cted from various sources, most freely from Storer's " Dic- ry of Solubilities " ; it makes no profession of accuracy olubilities, as authorities differ so widely on this point ference to almost all of the bodies not in extensive daily but I trust the degree of accuracy aimed at, and in most I hope arrived at, is such as to meet the want which I endeavoured to supply, namely, such information as the nser or pharmaceutical operator frequently has occasion k while carrying on the common processes of the shop. ixture is prescribed with more saline matter than the readily takes up, it is desirable to know whether the ation of heat will effect a permanent solution of the , or whether there will be a deposition of crystals when ls again. When a substance is prescribed, or is desired prescribed, it is convenient to know whether the same be le in water, spirit, ether, or other solvents suitable for al or external use ; for these and such like purposes an ximation to accuracy is all that is demanded, and where se of decimal points might be understood to indicate a ssion of great accuracy, they are in most cases put in as a of calculating from the quantity of water required for dissolving one part of salt into the quantity of salt dissolved by 100 of water; in many other cases the decimal points are put in only for the sake of avoiding an ambiguity which would result from their use in one case and not in another.

The formulæ and equivalent numbers having been collected from many sources, and based upon different theoretical views, will no doubt meet with criticism such as I should willingly have avoided had it been practicable to make them uniform and consistent in principle. They are not intended for the professional chemist, but for the pharmaceutical worker; and as they have been of service to myself on many occasions when a chemical had to be prepared in the absence of precise working instructions, I trust they will be useful to others similarly situated. Some substances are on the list without any appended information; they may be taken as indicating a good intention, and affording my readers facility to fill in information as they get the opportunity.

The term hot water may generally be understood to mean 212° Fahr., but in some cases it may mean the boiling point of a saturated solution of the substance in question; in other cases the authority quoted may have used a lower temperature,

Name.	Formula.	Equivalent number.	Specific gravity.	Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
				Cold.	Hot.	Cold.	Hot.			
Acid Acetic Glac.	$C_4H_3O_3HO$ ..	60·0	1·065	soluble in all proportions	soluble in all proportions	soluble in all proportions	soluble in all proportions			
,, Arsenic	AsO_5	115·0	solution, 2·55 to 1·93	244·8	.. ..	freely soluble	.. ..	.. ..	slightly soluble in oils	
,, Arsenious ..	AsO_3	99·0	3·699	1·0	10·0	.. ..	.. ..	.. ..	.. ..	Authorities disagree regarding solubility of AsO_3. It is *very* slow of solution, and the varieties differ.
,, Benzoic	$C_{14}H_5O_3HO$ ..	112·0	.. ..	0·5	4·0	freely soluble	.. ..	soluble ..	fixed and volatile oils, &c.	
,, Boracic	BO_3 3 HO	61·8	1·48	2·0	20·0	soluble	.. ..	.. ..	oils, acetic acid, glycerine	
,, Carbolic....	$C_{12}H_5OHO$ ..	94·0	1·065	about 5	.. ..	freely soluble	.. ..	soluble	glycerine, acetic acid, oils, &c.	Much less soluble in brine than in water; more soluble in alkaline liquors.
,, Chromic...	CrO_3	50·28	..	very soluble	.. ..	soluble	decomposed	soluble	.. ..	Most chromates are insoluble in water, but soluble in nitric acid.
,, Citric	3 HO $C_{12}H_3O_{11}$ 2 Aq	210·0	.. ..	133·0	200·0	87·0	very soluble	soluble with heat	glycerine, &c.	

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
l pro- rtions	.. ..	all proportions	.. ..	soluble ..	glycerine	
1·0	30·0	soluble	easily soluble	soluble ..	glycerine,&c.	
ry oluble	.. ..	soluble				
72·0	.. ..	68·0	.. ..	.. ..	essential oils, glycerine	
pro- rtions	.. ..	all proportions	.. ..	soluble ..	essential oils, glycerine, chloroform	The solution in glycerine and oils is more permanent than that in water.
vols.	.. ..	10 vols.	.. ..	soluble ..	glycerine ..	Some saline solutions dissolve less HS than water does. The glycerine solution is more permanent than the aqueous.
ry oluble	.. ..	soluble				
ry oluble	.. ..	very slightly	.. ..	soluble	.. ..	The stronger the spirit the less iodic acid it dissolves.
pro- rtions	.. ..	all proportions	.. ..	soluble		
00·0	.. ..	decomposes				
oluble	.. ..	freely soluble	.. ..	soluble in all proportion	essential oils, &c.	Freezes at 40° Fahr.
wly	.. ..	freely	.. ..	freely soluble	.. ..	Alcoholic solution

,, Perchloric..	ClO_7	91·5	.. ..	very soluble	.. ..	soluble				discordant.
,, Phosphoric..	PO_5	71·0	.. ..	very soluble	.. ..	very soluble	.. ..	soluble ..	.. ..	Difficultly crystallizable.
,, Phosphorous	PO_3	55·0	.. ..	very soluble						
,, Pyrogallic..	$C_{12}H_6O_6$	126·0	.. ..	40·0	.. ..	soluble	.. ..	soluble		
,, Salicylic ..	$C_{14}H_5O_5 . Aq$ ..	138·0	.. ..	0·5	more freely soluble	freely soluble	freely soluble	freely soluble	hot essential oils	
,, Stearic	$C_{68}H_{66}O_5$	514·0	.. ..	insoluble	insoluble	soluble	freely soluble	8·0	benzine oils, &c.	Melts at 159° Fahr.
,, Succinic....	$C_8H_8O_5$	91·0	.. ..		45·0	30·0	60·0	soluble ..	essential oils	
,, Sulphuric ..	SO_3	40·0	.. ..	soluble in all proportions	soluble in all proportions	miscible with decomposition	miscible with decomposition			
,, Sulphurous..	SO_2	32·0	gas, 2·23	about 10	..	very soluble	.. ..	soluble ..	essential oils	Solubility in water greatly increased by reduction of temperature.
,, Tannic	$C_{54}H_{22}O_{34}$	618·0	.. ..	very soluble	.. ..	very soluble	.. ..	very soluble	glycerine ..	Precipitated from aqueous solution by mineral acids.
,, Tartaric....	$C_8H_4O_{10}$	132·0	.. ..	75·0	.. ..	50·0	.. ..	insoluble ..	.. ..	Authorities vary regarding the solubility in water. Probably the acid itself varies.
,, Valerianic..	$C_{10}H_9O_3$	93·0	.. ..	3·0	.. ..	freely soluble	.. ..	all proportions		
Aconitine	(?) $C_{60}H_{47}NO_{14}$ ..	533·0	.. ..	less than 1·0	2·0	freely	.. ..	freely	chloroform	

olubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
old.	Hot.	Cold.	Hot.			
pro- rtions	.. ..	all proportions	.. ..	soluble ..	glycerine	
1·0	30·0	soluble	easily soluble	soluble ..	glycerine,&c.	
ry oluble	.. ..	soluble				
72·0	.. ..	68·0	.. ..	.. ..	essential oils, glycerine	
pro- rtions	.. ..	all proportions	.. ..	soluble ..	essential oils, glycerine, chloroform	The solution in glycerine and oils is more permanent than that in water.
vols.	.. ..	10 vols.	.. ..	soluble ..	glycerine ..	Some saline solutions dissolve less HS than water does. The glycerine solution is more permanent than the aqueous.
ry oluble	.. ..	soluble				
ry oluble	.. ..	very slightly	.. ..	soluble	.. ..	The stronger the spirit the less iodic acid it dissolves.
pro- rtions	.. ..	all proportions	.. ..	soluble		
00·0	.. ..	decomposes				
oluble	.. ..	freely soluble	.. ..	soluble in all proportion	essential oils, &c.	Freezes at 40° Fahr.
	.. ..	freely	.. ..	freely soluble	.. ..	Alcoholic solution

,, Perchloric..	ClO_7	91·5	.. ..	very soluble	.. ..	soluble				discordant.
,, Phosphoric..	PO_5	71·0	.. ..	very soluble	.. ..	very soluble	.. ..	soluble ..	.. ..	Difficultly crystallizable.
,, Phosphorous	PO_3	55·0	.. ..	very soluble						
,, Pyrogallic..	$C_{12}H_6O_6$	126·0	.. ..	40·0	.. ..	soluble	.. ..	soluble		
,, Salicylic ..	$C_{14}H_5O_5 . Aq$ ..	138·0	.. ..	0·5	more freely soluble	freely soluble	freely soluble	freely soluble	hot essential oils	
,, Stearic	$C_{68}H_{66}O_5$	514·0	.. ..	insoluble	insoluble	soluble	freely soluble	8·0	benzine oils, &c.	Melts at 159° Fahr.
,, Succinic....	$C_8H_8O_5$	91·0	.. ..		45·0	30·0	60·0	soluble ..	essential oils	
,, Sulphuric ..	SO_3	40·0	.. ..	soluble in all proportions	soluble in all proportions	miscible with decomposition	miscible with decomposition			
,, Sulphurous..	SO_2	32·0	gas, 2·23	about 10	..	very soluble	.. ..	soluble ..	essential oils	Solubility in water greatly increased by reduction of temperature.
,, Tannic	$C_{54}H_{22}O_{34}$	618·0	.. ..	very soluble	.. ..	very soluble	.. ..	very soluble	glycerine ..	Precipitated from aqueous solution by mineral acids.
,, Tartaric....	$C_8H_4O_{10}$	132·0	.. ..	75·0	.. ..	50·0	.. ..	insoluble ..	.. ..	Authorities vary regarding the solubility in water. Probably the acid itself varies.
,, Valerianic..	$C_{10}H_9O_3$	93·0	.. ..	3·0	.. ..	freely soluble	.. ..	all proportions		
Aconitine	(?) $C_{60}H_{47}NO_{14}$ ..	533·0	.. ..	less than 1·0	2·0	freely	.. ..	freely	chloroform	

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
ar- ingly 1·5	freely 20·0	freely	.. ..	insoluble		
9·0	420·0					
20·0	.. ..	.. ..	.. ..	.. ..	.. ..	Decomposed by boiling into a lower hydrate which is very soluble.
20·0	very soluble	insoluble				
9·0	357·0					
10·0	.. ..	.. ..	.. ..	.. ..	.. ..	Liable to decomposition by heat.
70·0	.. ..	very soluble				
50·0	.. ..	insoluble	.. ..	.. ..	.. ..	Insoluble in strong acetic acid.
ry oluble	.. ..	very soluble	.. ..	.. ..	.. ..	Volatilizes along with water when its solution is evaporated.
ry oluble	.. ..	very soluble				

,, Chloride ..	NH_4Cl	53·5	.. ..	35·0	100·0	1·5	7·0			carbonate is soluble in spirit.
,, Chromate..	$NH_4O\,CrO_3$ ..	78·0	.. ..	very soluble	.. ..	insoluble				
,, Citrate	$3\,NH_4O\;C_{12}H_5O_{11}$	243·0	.. ..	very soluble	.. ..	slightly soluble	more soluble	.. ..	.. ..	Deliquescent.
,, Fluoride ..	NH_4Fl	37·0	.. ..	freely soluble	.. ..	sparingly soluble	.. ..	.. ..	.. ..	The acid fluoride is very soluble.
,, Formiate ..	NH_4O, Fo.. ..	63·0	.. ..	deliquescent						
,, Iodide	NH_4I..	145·0	.. ..	very deliquescent	.. ..	very soluble				
,, Lactate ..	.. ..	.. ..	.. ..	deliquescent	.. ..	14·0	.. ..	insoluble		
,, Molybdate.										
,, Nitrate....	NH_4ONO_5	80·0	.. ..	190·0	.. ..	.. ..	.. ..	.. ..	.. ..	Authorities differ much regarding the solubility of this salt.
,, Oxalate ..	NH_4OOx Aq ..	71·0	.. ..	4·0	freely soluble	insoluble	.. ..	.. ..	.. ..	The acid salt is less soluble than the neutral.
,, Phosphate .	$2\,NH_4O, PO_5Aq$	132·0	.. ..	50·0	.. ..	insoluble	.. ..	.. ..	.. ..	The solution loses ammonia when heated.
,, Salicylate..	.. ..	.. ..	.. ..	very soluble						
,, Succinate..	$3\,NH_4O$, Sc ..	169·0	.. ..	readily soluble	.. ..	readily soluble	.. ..	readily soluble	creosote ..	Loses ammonia by exposure to the air.

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
75·0	.. ..	sparingly soluble	.. ..	.. ..	.. ..	Almost insoluble in alcohol, but freely soluble in proof spirit.
liquescent	.. ..	freely soluble				
reely soluble	.. ..	insoluble				
ery soluble	.. ..	insoluble	.. ..	.. ..	.. ..	The neutral salt more soluble in cold than in hot water. The acid salt sparingly soluble in cold but freely in hot, and quite insoluble in pure alcohol.
paringly soluble	freely soluble	insoluble				
liquescent	.. ..	freely soluble				
ery sparingly						
soluble	.. ..	freely	.. ..	freely	fusel oil, &c.	

	•		2·50							
,, Nitrate....	.. ..	.. ..	.. ..	insoluble	sparingly soluble	freely soluble	.. ..	freely soluble		
,, Nitrite	.. ..	.. ..	.. ..	insoluble	.. ..	freely soluble	.. ..	freely soluble	oils, &c.	
Aniline	$C_{12}H_7N$	93·0	1·02	insoluble	.. ..	freely soluble	.. ..	freely soluble	oils, &c.	
,, Chloride ..										
,, Nitrate....										
,, Sulphate ..										
Antimony	Sb	129·0	6·7							
,, Arseniate..	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	.. ..	Decomposed by water.
,, Bromide ..	$SbBr_3$..	369·0	.. ..	deliquescent	.. ..	.. ..	.. ..	.. ..	.. ..	Decomposed by water.
,, Chloride ..	$SbCl_3$	235·0	.. ..	deliquescent	.. ..	.. ..	.. ..	.. ..	.. ..	Decomposed by water.
,, Iodide	SbI_3	503·0	.. ..	decomposed	.. ..	decomposed	.. ..	.. ..	hydriodic and hydrochloric acids	Decomposed by water or spirit.
,, Sulphate ..	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	sulphuric acid	Decomposed by water.
,, Tartrate & Potash ..	$KO, SbO_3, HO, C_8H_4O_{10}$	341·0	.. ..	7·0	50·0	.. ..	.. ..	.. ..	glycerine	Insoluble in absolute alcohol.
Apomorphia										
Arsenic	As	75·0	5·7							
,, Bromide ..	$AsBr_3$	315·0	.. ..	decomposed	.. ..	.. ..	.. ..	.. ..	.. ..	Decomposed by water to a soluble acid salt and insoluble basic.

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
luble n a mall quan- ity of water	.. ..	soluble	.. ..	soluble ..	oils, &c. ..	Soluble without decomposition in a small quantity of water, but decomposed on dilution into arsenious and hydrochloric acids.
luble	.. ..	.. ..	.. ..	.. ..	.. ..	Decomposed by a small bulk of water, but entirely dissolved when largely diluted.
soluble	.. ..	insoluble	.. ..	.. ..	solutions of alkaline sulphides, &c.	
soluble	.. ..	.. ..	.. ..	.. ..	solutions of alkaline sulphides, &c.	
0·2	1·4	freely soluble	.. ..	freely soluble	chloroform, oils, &c.	
reely, 100·0	.. ..	freely, 30·0	.. ..	sparingly		
ry soluble	.. ..	soluble	.. ..	not freely soluble		

										or 1,000 of water with carbonic acid.
,, Chlorate ..	$BaOClO_5,Aq$ ..	161·1	.. ..	50·0	120·0	insoluble	.. ..	.. ..	.. ..	Sparingly soluble in proof spirit.
,, Chloride ..	BaCl	104·0	3·9	35·0	75·0	sparingly	.. ..	.. ..	.. ..	Proof spirit dissolves about 1 per cent.; pure alcohol none.
,, Chromate..	$BaOCrO_3$	128·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	dilute mineral acids	
,, Citrate	$3\ BaOC_{12}H_5O_{11}$	394·5	.. ..	sparingly soluble	.. ..	.. ..	.. ..	.. ..	solution of citric and other acids	More soluble when precipitated cold than when from hot solutions.
,, Fluoride ..	BaFl	87·5	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	solution of citrate of soda	Soluble in hydrofluoric acid.
,, Formate ..	C_2HBaO_4	113·5	.. ..	25·0	.. ..	insoluble				
,, Hydrate ..	BaOHO	85·6	.. ..	2·0 or 3·0	50·0	soluble	.. ..	insoluble ..	syrup	
,, Hypophosphite	BaO 2 HO PO, Aq	143·5	.. ..	28·0	33·0	insoluble				
,, Iodide	BaI	195·5	.. ..	200·0 very soluble	300·0	freely soluble				
,, Lactate, Bi-	BaOHO $C_{12}H_{10}O_{10}$	247·5	.. ..	soluble	.. ..	soluble	.. ..	insoluble	.. ..	Insoluble in absolute alcohol; soluble in proof spirit.
,, Nitrate....	$BaONO_5$	130·5	.. ..	8·0	35·0	slightly soluble	.. ..	.. ..	.. ..	Much less soluble in dilute nitric and hydrochloric acids; almost insoluble in the strong acids.
,, Oleate	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	slightly soluble	slightly soluble	oleic acid	May be crystallized from boiling alcohol.

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
arly insoluble	.. ..	.. ..	.. ..	.. ..	solution of citrate of soda or chloride of ammonium	Soluble in acetic and oxalic acids.
luble						
ry sparngly soluble	.. ..	.. ..	.. ..	.. ..	solution of ammonium chloride and soda citrate	Soluble in phosphoric, nitric, and some other acids.
soluble	.. ..	.. ..	.. ..	.. ..	.. ..	Traces of sulphate of baryta are dissolved by nitric and hydrochloric acids.
luble	.. ..	.. ..	.. ..	.. ..	.. ..	When dissolved in water it is converted into hydrate and sulphydrate of baryta.
aringly luble	.. ..	.. ..	.. .. soluble	.. ..	sulphurous acid	
ry sparingly	.. ..	soluble	.. ..	soluble ..	chloroform, oils, &c.	A good solvent of essential oils, fats, &c.

,, Hydrochlorate	.. ..	.. ..	.. ..	0·14	.. ..	soluble			acids	
Bismuth........	Bi	210·0								
,, Bromide ..	$BiBr_3$	450·0	.. ..	decomposed	.. ..	.. ..	.. ..	.. ..	.. ..	Decomposed by water.
,, Carbonate..	2 $(BiO_3CO_2)HO$	521·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	solution of chloride of ammonium	Insoluble in carbonic acid water.
,, Chloride ..	$BiCl_3$	319·0	.. ..	deliquescent	.. ..	.. ..	.. ..	.. ..	dilute hydrochloric acid or citric acid	Decomposed by water into oxychloride of bismuth and hydrochloric acid.
,, Chromate..	BiO_3 3 CrO_3 ..	390·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	dilute nitric and hydrochloric acids	Not soluble in aqueous chromic acids.
,, Citrate....	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	.. ..	Soluble in alkaline citrates.
,, Iodide ..	Bi_2I_3	593·5	.. ..	decomposed	.. ..	.. ..	.. ..	.. ..	solution of iodide of potassium	Decomposed by water.
,, Nitrate ..	Bi_2O_3 3NO_5 10Aq	488·8	.. ..	decomposed	.. ..	.. ..	.. ..	.. ..	Aqueous citric and acetic acids	Decomposed into basic salt which precipitates, and an acid salt which remains in solution [(?) BiO_3 12 NO_5]
,, ,, Sub-	BiO_3NO_5 2 Aq ..	306·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	.. ..	The subnitrate continues to yield nitric acid and bismuth to water [(?) BiO_3 12 NO_5] till little else than oxide remains.

olubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
old.	Hot.	Cold.	Hot.			
oluble						
oluble	.. ..	.. ..	.. ..	.. ..	solution of chloride of ammonium, citrate of soda	
oluble	.. ..	.. ..	.. ..	.. ..	solution of chloride of ammonium	Soluble in hydrochloric acid.
oluble	.. ..	.. ..	.. ..	.. ..	.. ..	Insoluble in cold dilute tartaric acid.
oluble						
uble 3·0	.. .. 3·0	soluble freely soluble	.. ..	soluble freely soluble	benzine, sulphide of carbon, &c.	Under influence of light decomposes water, producing hydrobromic acid.
uble	.. ..	.. ..	.. ..	soluble ..	.. ..	Solution decomposed by sunlight.
ry par- ngly oluble	.. ..	soluble	.. ..	soluble ..	soluble in oils	
0·12	0·2	freely soluble	.. ..	insoluble ..	liquor ammonia	

Cadmium ……	Cd	56·0								
,, Bromide ..	CdBr	136·0	.. ..	deliquescent	.. ..	readily soluble	.. ..	readily soluble	.. ..	*Soluble without decomposition in hydrochloric acid.*
,, Carbonate .	CdO CO_2	86·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	Chloride of ammonia, cyanide of potassium, &c.	
,, Chloride ..	CdCl 2 Aq.. ..	109·5	.. ..	deliquescent						
,, Iodide ….	CdI	182·6	.. ..	readily soluble	.. ..	readily soluble	.. ..	very sparingly		
,, Nitrate ….	$CdONO_5$ 4 Aq ..	154·0	.. ..	deliquescent	.. ..	readily soluble	.. ..	.. ..	.. ..	Almost insoluble in strong nitric acid.
,, Phosphate .	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	soluble along with other salts of cadmium	
,, Sulphate ..	$CdOSO_3$	103·7	.. ..	100·0						
Caffeine ……	$C_{16}H_{10}N_4O_4$ 2 Aq	212·0	.. ..	sparingly, about 2·0	freely	5·0	.. ..	sparingly ..	chloroform and essential oils	
,, Citrate ….	.. ..	.. ..	.. ..	soluble	.. ..	.. ..	.. ..	.. ..	.. ..	The existence of a true citrate is doubtful.
Calcium ……	Ca	20·1								
,, Acetate ..	CaOAc	79·0	.. ..	16·0	.. ..	4·0				
,, Arseniate..	2 $CaOAsO_5+6Aq$	225·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	arsenic acid and ammonia salts	
,, Benzoate ..	CaOBz 4 Aq ..	177·0	.. ..	4·0	more soluble					
,, Borate ….	$CaOBO_3$ 2 Aq ..	81·0	.. ..	slightly soluble	more soluble	insoluble	.. ..	.. ..	solutions of ammonia salts	Other compounds of CaO with BO_3 less soluble.

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
140·0	300·0	very soluble				
soluble	.. ..	insoluble				
lmost insoluble	.. ..	insoluble	.. ..	.. ..	slightly soluble in chloride of ammonium	More soluble in carbonic acid water or lime water than in pure water.
very soluble	.. ..	freely soluble				
71·0	200·0					
400·0	.. ..	freely soluble	.. ..	.. ..	.. ..	Soluble in some of the compound ethers.
easily soluble	.. ..	insoluble				
oluble	less soluble	.. ..	.. ..	.. ..	acetic acid	Cold solutions precipitate the citrate on heating.
nsoluble	not quite insoluble	.. ..	.. ..	.. ..	slightly soluble in aqueous ammonia salts	
oluble	decomposed by boiling					
16·0	little more soluble with heat	very slightly				
100·0	decomposed	insoluble				

„ [illegible]	.. ..	.. ..	.. ..	[illegible]	[illegible]	[illegible]				
„ Iodide	CaI	147·0	.. ..	about 200·0	about 500·0	soluble				
„ Lactate....	$C_{12}H_{10}Ca_2O_{12}$ 8 Aq	290·0	.. ..	very soluble 8·0	very soluble	soluble	very soluble	insoluble..	.. ..	Other authorities say it is insoluble in absolute alcohol.
„ Malate....	.. ..	.. ..	.. ..	very sparingly	.. ..	very sparingly				
„ Nitrate....	CaO, NO_5 4 Aq	118·0	.. ..	400·0	.. ..	13·0	100·0			
„ Oxalate ..	CaO, C_2O_3 2 Aq	82·0	.. ..	insoluble	.. ..	insoluble	.. ..	insoluble ..	citrate of soda	Slightly soluble in oxalic and acetic acids, freely in hydrochloric.
„ Oxide	CaO	28·0	.. ..	0·13	0·08	almost insoluble	.. ..	insoluble ..	syrup ..	Gelatine and some other organic substances increase solubility in water.
„ Permanganate	.. ..	.. ..	.. ..	deliquescent						
„ Phosphate	3 CaO, PO_5 ..	155·0	.. ..	almost insoluble	.. ..	insoluble	.. ..	.. ..	.. ..	Freely soluble in hydrochloric acid, less freely in organic acids.
„ „ Super-	CaO, PO_5 2 Aq	117·0	.. ..	very soluble	.. ..	insoluble				
„ Phosphide	.. ..	.. ..	.. ..	decomposed						
„ Phosphite..	.. ..	.. ..	.. ..	soluble	.. ..	.. ..	.. ..	.. ..	.. ..	Both the acid and normal salt are soluble in water and precipitated by alcohol.

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
soluble	.. ..	.. ..	.. ..	.. ..	.. ..	When freshly precipitated, is soluble in water-glass solution.
0·24	0·21	.. ..	.. ..	.. ..	.. ..	More soluble in salt water.
0·2	.. ..	.. ..	.. ..	.. ..	glycerine	CaS_5 soluble in water and alcohol.
0·12	.. ..	.. ..	.. ..	.. ..	sulphurous acid	
oluble	.. ..	.. ..	.. ..	.. ..	.. ..	The basic salt almost insoluble.
ar- ngly soluble	rather more soluble	.. ..	.. ..	.. ..	tartaric acid and tartrates	Acetic and mineral acids also dissolve it.
0·1	.. ..	100·0	very soluble	very soluble	strong acetic acid, chloroform, oils, &c.	Lime and magnesia increase the solubility of camphor in water.
soluble	.. ..	slightly soluble	rather more soluble	3·0	benzine oils, hot acetic acid	Soluble in water, in the presence of other matters contained in the fly.

,,				cent						
,, Chloride ..	.. ..	.. ..	.. ..	100·0 ; deliquescent	.. ..	25·0 to 30·0 ; soluble				
,, Lactate....										
,, Nitrate....	Ce_2O_3 3 NO_5 ..	.. ..	.. ..	deliquescent	.. ..	soluble				
,, Oxalate ..	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. .. ..	.. ..	Soluble in nitric or hydrochloric acids.
,, Oxide	CeO	54·0	.. ..	insoluble						
Chinoline	C_9H_7N	.. ..	.. ..	sparingly	.. ..	soluble	.. ..	soluble ..	oils, &c. ..	Chinoline dissolves in water to a limited extent.
,, Tartrate ..	2 C_9H_7N 4 $C_4H_6O_6$	.. ..	.. ..	soluble	.. ..	soluble	.. ..			
Chloral Hydrate	$C_4HCl_3O_2$ 2 HO	.. ..	.. ..	very soluble	.. ..	very soluble	.. ..	insoluble very soluble	chloroform, camphor, essential oils	
Chlorine	Cl	35·5	.. ..	200·0 by vols.	.. ..	decomposes	.. ..	decomposes		
Chloroform......	C_2H, Cl_3	119·5	.. ..	0·7	.. ..	soluble	.. ..	soluble ..	oils, &c. ..	Soluble in all proportions in absolute alcohol.
Chromium	Cr	26·2								
,, Chloride ..	Cr_2Cl_3..	158·9	.. ..	deliquescent; very soluble	.. ..	soluble				
,, Nitrate....	Cr_2O_3 3 NO_5 18Aq	400·4	.. ..	freely soluble						
,, Oxalate ..	.. ..	.. ..	.. ..	freely soluble						
,, Phosphate	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	phosphoric and other acids	
,, Sulphate ..	Cr_2O_3 3 SO_3 ..	196·5	.. ..	111·0	modified by heat					

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
0·03	0·2	1·1	5·0	0·3		
1·0	6·0	freely soluble	.. ..	almost insoluble		
0·015	0·04	1·0	.. ..	slightly soluble	chloroform, 2·5	
luble ; bout 4	.. ..	soluble	.. ..	insoluble ..	acid solutions	
2·0	.. ..	9·0	14·0	.. .. ..	.. ..	More soluble with excess of acid.
ery par- ngly	.. ..	soluble				
ar- ngly oluble	more soluble	freely soluble				
eely oluble						
soluble						
eely oluble	.. ..	freely soluble				
eely oluble	.. ..	freely soluble				
1·0	2·0	readily soluble	.. ..	readily soluble		
ightly, 1·0	.. ..	freely soluble	.. ..	freely soluble	oils, &c. ..	Coniine dissolves water.
7·0	20·0	.. ..	8·0	insoluble		
soluble	.. ..	insoluble	.. ..	insoluble	liquor ammonia, acids	

„									ammonia, acids	
„ Borate	.. ..	.. ..	.. ..	slightly soluble	.. ..	.. ..	.. ..	.. ..	acids generally	
„ Bromide ..	.. ..	.. ..	.. ..	freely soluble; deliquescent						
„ Carbonate	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	solutions of ammonia and its salts	Also soluble in solution of cyanide of potassium, &c.
„ Chloride ..	CuCl	67·1	.. ..	60·0	.. ..	freely soluble	.. ..	soluble ..		
„ Chlorate ..	.. ..	.. ..	.. ..	very soluble	.. ..	easily soluble				
„ Chromate..	$CuOCrO_3$ 2 Aq ..	.. ..	.. ..	slightly soluble	.. ..	.. ..	.. ..	.. ..	acids or ammonia	
„ Cyanide ..	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	ammonia, cyanide of potassium	
„ Iodide	Cu_2I	190·2	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	iodide of potassium	Sparingly soluble in liquor ammonia.
„ Nitrate....	$CuONO_5$ 3 Aq ..	120·6	.. ..	100·0	.. ..	100·0				
„ Oxalate ..	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	alkaline oxalates	Not soluble in nitric acid
„ Phosphate	.. ..	.. ..	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	phosphoric acid	
„ Sulphate ..	$CuOSO_3$ 5 Aq ..	124·7	.. ..	20·0	50·0	insoluble	.. ..	.. ..	.. ..	Authorities differ much regarding solubility.
„ „ and Ammonia	.. ..	.. ..	.. ..	62·0						
„ Tartrate ..	.. ..	.. ..	.. ..	0·05	0·3	.. ..	.. ..	.. ..	caustic alkalies	Insoluble in tartaric acid.
Creosote	.. ..	.. ..	1·037	sparingly	.. ..	freely soluble	.. ..	soluble ..	acetic acid, oils	Not freely soluble in glycerine.

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
art soluble	.. ..	little soluble	.. ..	part soluble	.. ..	The soluble portion contains an alkaloid curara or curarine, regarding the properties of which authorities differ.
.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	Said to be identical with atropine.
elatinizes	dissolves freely	insoluble	slightly soluble	.. ..	.. ..	Other modifications are soluble in cold water.
soluble	.. ..	soluble	.. ..	very slightly	hydrochloric and acetic acids	Soluble in ammonia water.
lightly soluble	more soluble	freely soluble	.. ..	almost insoluble	dilute acids	In combination with the acids of ipecacuanha it dissolves in cold water.
10·0	less soluble	all proportions	.. ..	.. ..	oils, &c.	
10·0	.. ..	all proportions	.. ..	all proportions		

				ingly		soluble				
Fluorine	F..	19·0	.. ..							
Furfurine	$C_{30}H_{12}N_2O_6$ ..	268·0	.. ..	almost insoluble	0·7	readily soluble	.. ..	readily soluble		
,, Nitrate....	$C_{30}H_{12}N_2O_6$ NO_5HO	331·0	.. ..	readily soluble						
Glucose	$C_{12}H_{12}O_{12}$ with 1 or 2 Aq	180·0; 9 or 18	.. ..	97·0	.. ..	soluble	.. ..	.. ..	.. ..	Sparingly soluble in absolute alcohol, but freely in weak spirit.
Glycerine	$C_6H_5O_3$ + 3 HO	92·0	.. ..	all proportions	.. ..	all proportions	.. ..	.. ..	.. ..	Glycerine dissolves most substances which are freely soluble in water or alcohol, and many others for which it is a special solvent.
Gold	Au	196·5								
,, Chloride .	$AuCl_3$ 6 Aq .	357·0	.. ..	60·0	.. ..	freely soluble	.. ..	freely soluble	.. ..	The alcoholic and ethereal solutions deposit metallic gold when long kept or exposed to light.
,, Cyanide,Ter-	$AuCy_3$ 6 Aq ..	328·5	.. ..	very soluble	.. ..	very soluble	.. ..	very soluble		
,, Iodide	AuI_3	577·5	.. ..	insoluble	sparingly soluble	.. ..	.. .	.. ..	iodide of potassium and other soluble iodides	
,, Stannate ..	AuO 3 SnO_2 4 Aq	465·5	.. ..	insoluble						

	Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
	Cold.	Hot.	Cold.	Hot.			
[redacted]	soluble	.. ..	insoluble	.. ..	soluble ..	benzine, chloroform, carbon sulphide, oil of turpentine	The composition and nature of gutta-percha are not quite constant.
[redacted]	iscible all pro-ortions						
[redacted]	0·2	.. ..	readily soluble	.. ..	soluble ..	oils	Forms salts soluble in water and alcohol.
[redacted]	ery soluble						
[redacted]	soluble	.. ..	insoluble	.. ..	insoluble	hot carbolic acid	Strong sulphuric acid dissolves it with combination.
[redacted]	par-ngly	more soluble	8·0 or 10·0	.. ..	30·0 ; soluble	benzine, chloroform, carbon sulphide, &c.	Soluble also in aqueous solutions of iodide.
[redacted]	soluble	.. ..	soluble	4·0	13·0	chloroform, carbon sulphide, oils, &c.	

											there are several, are generally soluble in mineral acids, and slightly so in arseniate of ammonia.
,, Arsenite ..	2 FeO, AsO_3 ..	171·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	.. ..	liquor ammonia	Insoluble in other ammonia compounds. The ferric salt is soluble in KO or NaO.
,, Benzoate ..	$C_{14}H_5FeO_4$ ..	149·0	.. ..	soluble	.. ..	soluble	.. ..	.. ..	.. ..	.. ..	The ferric salts are soluble which have acid in excess. The basic salts are insoluble.
,, Bromide....	FeBr 6 Aq ..	162·0	.. ..	very deliquescent	.. ..	soluble					
,, Carbonate ..											
,, Chloride, Per-	Fe_2Cl_3..	162·5	.. ..	deliquescent	.. ..	soluble	.. ..	soluble			
,, ,, Ammonio	.. ..	.. ..	.. ..	soluble	.. ..	soluble					
,, ,, Proto- ..	FeCl	63·5	.. ..	deliquescent	.. ..	100·0	.. ..	insoluble			
,, Chromate ..	$Fe_2O_3CrO_3$.. ..	130·3	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	.. ..	chromic, nitric, and other acids	The native chromates of iron are very difficult to dissolve.
,, Citrate	Fe_2O_3, Cit 3 Aq	272·0	.. ..	soluble	.. ..	insoluble	.. ..	.. ..	.. ..	alkaline citrates	Soluble while new, but becomes insoluble with age.
,, ,, Ammonio-	indefinite	.. ..	.. ..	very soluble	.. ..	insoluble					

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
nsoluble	.. ..	insoluble	.. ..	insoluble	solution of oxalic acid	Partially soluble in water free from salts, and in water containing ferrocyanide of potassium.
lightly soluble	.. ..	.. ..	.. ..	.. ..	freely soluble in acetic acid	Ferric gallate is less soluble than ferrous.
oluble	.. ..	.. ..	.. ..	.. ..	.. ..	The ferric salt is sparingly soluble in water, but more so in hypophosphorous or hydrochloric acid.
par-ingly soluble	.. ..	.. ..	.. ..	.. ..	aqueous solution of proto-sulphate of iron	The ferric salt is sparingly soluble in water, but soluble in perchloride of iron.
ery eliques-cent	.. ..	soluble	.. ..	.. ..	syrup, glycerine, &c.	The commercial salt has not generally the 4 Aq.
ot freely soluble	freely soluble	soluble	.. ..	.. ..	.. ..	The ferric salt is deliquescent, but insoluble in alcohol.
ery soluble	.. ..	very soluble				
reely soluble	decom-posed	.. ..	.. ..	.. ..	.. ..	The ferric salt is deliquescent and freely soluble in alcohol.

,, ,, Proto-	$FeO\ C_2O_3\ 2\ Aq.$ ..	90·0	.. ..	soluble almost insoluble	.. ..	insoluble	.. ..	.. ..	ferric oxalate with free oxalic acid	
,, Phosphate, Per-	$Fe_2O_3\ PO_5$	151·0	.. ..	insoluble	.. ..	insoluble	.. ..	insoluble	acids, alkaline phosphate of ammonia, citrate of soda, &c.	
,, Phosphate, Proto-	$3\ FeO, PO_5$ ..	179·0	.. ..	insoluble	.. ..	insoluble	.. ..	insoluble	phosphoric and many other acids	
,, Phosphite ..	$2\ FeO, HO\ PO_3$	136·0	.. ..	sparingly soluble						
,, Salicylate ..										
,, Succinate ..	$2\ FeO\ C_8H_4O_6$	172·0	.. ..	nearly insoluble	.. ..	.. ..	.. ..	.. ..	aqueous solutions of ammoniacal salts	Several ferric succinates exist, having little solubility in water, but soluble in mineral acids.
,, Sulphate, Per-	$Fe_2O_3\ 3\ SO_3\ 9\ Aq.$	281·0	.. ..	very soluble	.. ..	freely soluble	.. ..	.. ..	.. ..	Insoluble in oil of vitriol.
,, ,, Proto-	$FeO\ SO_3\ 7\ Aq.$	139·0	.. ..	70·0	300·0					
,, Sulpho-carbolate										
,, Tannate ..	.. ..	.. ..	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	.. ..	Both ferrous and ferric tannates are soluble with decomposition in oxalic, or strong mineral acids.

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
par- ingly soluble	.. ..	.. ..	.. ..	.. ..	alkaline solutions and alkaline tartrates.	The ferric salt is more soluble, and forms readily soluble compounds with alkaline tartrates.
oluble	.. ..	insoluble	.. ..	insoluble		
nsoluble	decomposed	soluble	.. ..	.. ..	readily soluble in acids	The ferrous salt is slightly soluble in water.
100·0	200·0	sparingly soluble	.. ..	insoluble		
lightly soluble	.. ..	.. ..	.. ..	.. ..	.. ..	Insoluble in liquor potassæ, soluble in liquor sodæ. Basic salts less soluble in water.
lightly soluble	.. ..	.. ..	.. ..	.. ..	.. ..	Boracic acid and oxide of lead combine in all proportions if fused together, forming glassy compounds.
ery spar-	.. ..	.. ..	.. ..	.. ..	citrate of soda	

				soluble					lutions, carbonic acid, &c.	given is said to be the most usual.
„ Chlorate ..	PbO ClO_3	187·0	.. ..	easily soluble	.. ..	easily soluble				
„ Chloride ..	PbCl..	139·0	.. ..	(?) 4·5	more soluble					
„ Chromate ..	PbO CrO_3	161·7	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	liquor potash, strong nitric acid dissolves more than 1 per cent.	Not precipitated from solutions containing citrate of soda.
„ Formate ..	C_2HPbO_4	148·5	.. ..	3·0	.. ..	nearly insoluble				
„ Hypophosphite	PbO HO PO ..	159·5	.. ..	difficultly soluble	easily soluble	insoluble				
„ Hyposulphite	PbO S_2O_2	159·5	.. ..	very sparingly	.. ..	.. ..	.. ..	.. ..	hyposulphite of ammonia	
„ Iodide	PbI	230·5	.. ..	very sparingly	0·5	slightly soluble	.. ..	.. ..	soluble iodides and citrates	
„ Nitrate	PbO NO_5	165·5	.. ..	50·0	100·0					
„ Oleate	PbO $C_{36}H_{33}O_3$ ..	384·5	.. ..	insoluble	.. ..	insoluble	.. ..	soluble	fats, oils, &c.	
„ Oxalate ..	PbO C_2O_3	147·5	.. ..	insoluble	.. ..	insoluble				
„ Oxide	PbO	111·5	.. ..	nearly insoluble	.. ..	insoluble	.. ..	.. ..	.. ..	Not quite insoluble in pure water; more soluble in presence of sugar, &c., and in alkaline solutions.
„ Phosphate	2 PbO HO PO_5..	303·0	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	dilute nitric acid	

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
nsoluble	.. ..	insoluble	.. ..	.. ..	alkaline acetates, citrates, tartrates	Slightly soluble in oil of vitriol, more so in potash lye.
nsoluble						
nsoluble	.. ..	.. ..	.. ..	.. ..	.. ..	Sparingly soluble in sulphurous acid. One of the most insoluble salts known.
nsoluble	.. ..	insoluble	.. ..	insoluble ..	liquor potash and alkaline tartrates	Soluble also in tartaric and nitric acids.
300·0	.. ..	20·0	.. ..	sparingly soluble		
reely soluble						
200·0						
ery sparingly	0·8	.. ..	.. ..	.. ..	carbonic acid water	
xceedingly	.. ..	soluble				
eliquescent						
oluble						

				cent						
,, Oxalate ..	LiO,C_2O_3	50·5	.. ..	readily soluble	.. ..	insoluble	.. ..	insoluble		
,, Oxide	LiO HO	23·5	.. ..	about 5·0; slowly soluble	.. ..	sparingly soluble				
,, Phosphate..	LiO 2 HO PO_5 ..	103·5	.. ..	deliquescent	.. ..	.. ..	.. ..	.. ..	.. ..	The phosphates containing 2 and 3 LiO are sparingly soluble, except in acids.
,, Salicylate..										
,, Sulphate ..	LiO SO_3 Aq ..	63·5	.. ..	34·6; very soluble	less soluble(?)	soluble(?)				
Magnesium	Mg	12·0	1·7							
,, Acetate....	MgO $C_4H_3O_3$, 4 Aq	107·0	.. ..	100·0	.. ..	very soluble				
,, Borate	MgO BO_3 8 Aq..	126·8	.. ..	insoluble	insoluble	.. ..	.. ..	.. ..	.. ..	Soluble in HCl.
,, Borocitrate.										
,, Bromide ..	MgBr 6 Aq ..	164·0	.. ..	very soluble						
,, Carbonate..	3 MgO, CO_2 + MgO, 5 Aq	142·0	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	carbonic acid water and some neutral salts	
,, Chloride ..	MgCl..	47·5	2·17	100·0; deliquescent	.. ..	14·0				
,, Citrate	$C_{12}H_5Mg_3O_{14}$ .. + 14 Aq	351·0	.. ..	soluble	.. ..	insoluble	.. ..	.. ..	.. ..	Only soluble when fresh.
,, Hypophosphite	MgO 2 HO PO 6 Aq	131·0	.. ..	freely soluble						
,, Hyposulphite	MgO, S_2O_2 6 Aq	122·0	.. ..	very soluble	more soluble					

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
deliquescent						
3·5	.. ..	insoluble	.. ..	insoluble ..	.. ..	That with 8 Aq is the more soluble salt.
soluble						
200·0	.. ..	very soluble				
nearly nsoluble	.. ..	insoluble				
nsoluble	.. ..	insoluble	.. ..	.. ..	.. ..	The hydrate is soluble in syrup; also in ammoniacal salts.
soluble	.. ..	soluble	.. ..	.. ..	.. ..	The basic salts are insoluble except in acids; they contain 2 and 3 MgO.
32·7	72·3	insoluble				
0·8	.. ..	.. ..	.. ..	.. ..	ammoniacal salts, tartaric acid	
soluble	.. ..	sparingly soluble				
30·0	.. ..	soluble				
nearly nsoluble	.. ..	.. ..	.. ..	.. ..	.. ..	Soluble in acids with decomposition.
60·0	120·0	50·0	70·0			
readily soluble	.. ..	decomposed	.. ..	.. ..	.. ..	The salts with 2 and 3 MnO are sparingly soluble.

Mercury........	Hg	100·0								
,, Acetate ..	$Hg_2O, C_4H_3O_3$ ..	259·0	.. ..	sparingly soluble	more soluble	insoluble	.. ..	.. ..	acetic acid..	Mercuric acetate is more freely soluble both in water and alcohol.
,, Bromide, Per-	$HgBr_2$	260·0	.. ..	0·2	4·0	8·0	33·0	freely soluble		
,, ,, Proto-	HgBr..	180·0	.. ..	insoluble	.. ..	insoluble				
,, Carbonate	$HgOCO_2$	130·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	.. ..	The mercurous carbonate is also insoluble, and decomposed by boiling water.
,, Chloride, Per-	HgCl..	135·5	.. ..	5·0	30·0	30·0	60·0	25·0 soluble	alkaline chlorides	
,, ,, Sub-	Hg_2Cl	235·5	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	aqua regia, solution of chloride of ammonium with heat	
,, Chromate..	Hg_2O, CrO_3 ..	258·3	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	.. ..	Converted by nitric acid into mercuric chromate.
,, Cyanide ..	HgCy..	126·0	.. ..	12·0	50·0	nearly insoluble				
,, Iodide, Per-	HgI	227·0	.. ..	insoluble	.. ..	0·8	8·0	sparingly ..	fixed oils, glycerine, hot brine	Forms soluble double salt with KI.
,, ,, Sub-	Hg_2I..	327·0	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	slightly soluble with KI	
,, Nitrate....	$HgONO_5$	162·0	.. ..	deliquescent						

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
nsoluble	.. ..	insoluble	.. ..	insoluble	solution of oxalic acid	Partially soluble in water free from salts, and in water containing ferrocyanide of potassium.
lightly soluble	.. ..	.. ..	.. ..	.. ..	freely soluble in acetic acid	Ferric gallate is less soluble than ferrous.
oluble	.. ..	.. ..	.. ..	.. ..	.. ..	The ferric salt is sparingly soluble in water, but more so in hypophosphorous or hydrochloric acid.
paringly soluble	.. ..	.. ..	.. ..	.. ..	aqueous solution of proto-sulphate of iron	The ferric salt is sparingly soluble in water, but soluble in perchloride of iron.
ery eliquescent	.. ..	soluble	.. ..	.. ..	syrup, glycerine, &c.	The commercial salt has not generally the 4 Aq.
ot freely soluble	freely soluble	soluble	.. ..	.. ..	.. ..	The ferric salt is deliquescent, but insoluble in alcohol.
ery soluble	.. ..	very soluble				
reely soluble	decomposed by	.. ..	.. ..	.. ..	.. ..	The ferric salt is deliquescent and freely soluble in alcohol.

				ingly soluble						
,, ,, Proto-	$FeO\ C_2O_3\ 2\ Aq.$..	90·0	.. ..	almost insoluble	.. ..	insoluble	.. ..	.. ..	ferric oxalate with free oxalic acid	
,, Phosphate, Per-	$Fe_2O_3\ PO_5$.. ..	151·0	.. ..	insoluble	.. ..	insoluble	.. ..	insoluble	acids, alkaline phosphate of ammonia, citrate of soda, &c.	
,, Phosphate, Proto-	$3\ FeO,\ PO_5$ ..	179·0	.. ..	insoluble	.. ..	insoluble	.. ..	insoluble	phosphoric and many other acids	
,, Phosphite ..	$2\ FeO,\ HO\ PO_3$	136·0	.. ..	sparingly soluble						
,, Salicylate ..										
,, Succinate ..	$2\ FeO\ C_8H_4O_6$	172·0	.. ..	nearly insoluble	.. ..	.. ..	.. ..	.. ..	aqueous solutions of ammoniacal salts	Several ferric succinates exist, having little solubility in water, but soluble in mineral acids.
,, Sulphate, Per-	$Fe_2O_3\ 3\ SO_3\ 9\ Aq.$	281·0	.. ..	very soluble	.. ..	freely soluble	.. ..	.. ..	.. ..	Insoluble in oil of vitriol.
,, ,, Proto-	$FeO\ SO_3\ 7\ Aq.$	139·0	.. ..	70·0	300·0					
,, Sulpho-carbolate										
,, Tannate ..	.. ..	.. ..	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	.. ..	Both ferrous and ferric tannates are soluble with decomposition in oxalic, or strong mineral acids.

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
ll proportions	.. ..	all proportions	.. ..	all proportions	oils, &c. ..	Ether abstracts it from aqueous solutions. Acetic acid abstracts it from oily solutions.
lightly soluble	.. ..	soluble	.. ..	soluble		
nsoluble	.. ..	sparingly soluble	more soluble	soluble		
nsoluble	.. ..	sparingly soluble	3·0	soluble ..	benzine, chloroform, sulphide of carbon	
nsoluble	.. ..	slightly soluble	.. ..	.. ..	fixed and volatile oils	Soluble in about 320 parts of absolute alcohol, in 80 of ether, and very freely in sulphide of carbon.
early nsoluble	sparingly soluble	3·0	100·0			
oluble	.. ..	soluble	.. ..	soluble ..	.. ..	Alcoholic or ethereal solutions decompose

Potassium	K	39·0							some other iodides	insoluble in water.
,, Acetate ..	KO, $C_4H_3O_3$ ..	98·0	.. ..	200·0	.. ..	50·0 freely soluble				
,, Antimoniate	$KOSbO_5$	209·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	.. ..	Forms hydrates with 1 and 3 Aq.
,, Arseniate..	$KOAsO_5$ 2 HO..	108·0	.. ..	20·0	.. ..	insoluble	.. ..	.. ..	.. ..	The alkaline salts are deliquescent, containing 2 and 3 equivalents of KO.
,, Arsenite ..	KO, AsO_3	146·0	.. ..	soluble	.. ..	slightly soluble	.. ..	.. ..	.. ..	Other compounds with 2 KO, or with 2 AsO_3, both soluble in Aq.
,, Benzoate ..	$C_{14}H_5KO_4$	160·0	.. ..	soluble	.. ..	soluble	.. ..	.. ..	.. ..	Deliquescent. The salt with 2 Bz is less soluble.
,, Borate	KO 2 BO_3 5 Aq..	162·0	.. ..	freely soluble						
,, Bromate ..	$KOBrO_5$	167·0	.. ..	6·6	48·0	sparingly soluble				
,, Bromide ..	KBr	119·0	.. ..	70·0	100·0	0·5	5·0	.. ..	.. ..	More soluble in proof spirit.
,, Carbonate, Bi-	KO, HO, 2 CO_2	100·0	.. ..	30·0	decomposes under 212° F.	almost insoluble				
,, ,, Sub-	KO, CO_2	69·0	.. ..	110·0	205·0	almost insoluble	.. ..	.. ..	.. ..	Commercial contains about 16 per cent. of Aq.
,, Chlorate ..	KO, ClO_5	122·5	.. ..	6·0	60·0	0·8				
,, Chloride ..	KCl	74·5	.. ..	33·0	59·2	slightly soluble	2·0	insoluble		

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
10·0	100·0	insoluble				
50·0	60·0					
oluble	.. ..	slightly soluble				
100·0	.. ..	slightly soluble	.. ..	.. ..	.. ..	Facilitates the solution of many less soluble cyanides.
40·0	80·0	sparingly soluble				
28·0	90·0	insoluble				
ery eliques- ent	.. ..	sparingly soluble				
ery soluble	.. ..	freely soluble				
ery eliques- ent	.. ..	very soluble	.. ..	insoluble		
ery soluble	.. ..	insoluble				
7·5	.. ..	insoluble	.. ..	.. ..	solution of KI	
140·0	200·0	16·0	.. ..	.. ..	.. ..	Cold, absolute alcohol only dissolves 2 to 3

„ Nitrate	KO NO_5	101·0	.. ..	poses 25·0	240·0	sparingly soluble	.. ..	insoluble		.
„ Nitrite	KO NO_3	85·0	.. ..	freely soluble	.. ..	soluble				
„ Oleate	.. ..	.. ..	.. ..	25·0	more soluble	50·0	100·0	3·0	.. ..	Insoluble in brine or strong lye.
„ Oxalate....	KO Ox Aq.. ..	92·0	.. ..	30·0	more soluble	insoluble				
„ Oxalate Acid	KO 2 Ox 3 Aq ..	146·0	.. ..	2·5	15·0	very sparingly				
„ Oxide Hydr.	KOHO	56·0	.. ..	200·0	.. ..	freely soluble	.. ..	4·0	glycerine, fusel oil, wood spirit, &c.	
„ Permanganate	$KOMn_2O_7$	158·0	.. ..	6·0	.. ..	decomposed				
„ Phosphate ..	2 KO, PO_5 3 Aq..	174·0	.. ..	freely soluble	.. ..	freely soluble				
„ Salicylate ..	$KOHOC_{14}H_5O_5$..	185·0	.. ..	soluble	.. ..	soluble	.. ..	soluble		
„ Sulphate ...	KO, SO_3	87·0	.. ..	10·0	26·0	insoluble	.. ..	.. ..	glycerine	
„ Sulphide ..	KS	55·0	.. ..	very soluble	.. ..	soluble				
„ Sulphite ..	KO, SO_2 2 Aq ..	97·0	.. ..	deliquescent	.. ..	very sparingly	.. ..	insoluble		
„ Sulphocarbolate										
„ Sulphocyanide	KC_2NS_2	97·0	.. ..	very soluble	.. ..	freely soluble				
„ Tartrate ..	2 $KOC_8H_4O_{10}$ ..	226·0	.. ..	100·0	200·0	slightly soluble	0·4			

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
0·4	7·0	very sparingly	.. ..	insoluble ..	more soluble in most acid or alkaline solutions	Borax dissolves it copiously with combination.
2·0	3·0					
liquescent	.. ..	25·0				
soluble	.. ..	sparingly soluble	.. ..	sparingly soluble	.. ..	Soluble in mixed ether and alcohol.
0·3	0·5	50·0	.. ..	2·0	chloroform, benzine	Very soluble in absolute alcohol.
par-ingly soluble	readily soluble	soluble				
oluble						
oluble						
0·1	3·0	2·2	33·0			
oluble	much more soluble	soluble	much more soluble			
3·0 or 4·0	freely soluble	25·0 freely soluble	.. ..	.. ..	.. ..	More soluble in presence of free acids.
1·5	freely soluble					
par-	more soluble	readily soluble				

,, Salicylate..										
,, Sulphate ..	$C_{40}H_{21}N_2O_4$ $HOSO_3$ 7 Aq	436·0	.. ..	0·13	3·0	1·5	.. ..	insoluble	glycerine, acid liquors, &c.	
,, ,, "Sol."	$C_{40}H_{24}N_2O_4$ 2HO, 2 SO_3 14 Aq	548·0	.. ..	9·0	.. ..	3·0 freely soluble				
,, Tannate ..										
,, Tartrate ..	.. ..	.. ..	.. ..	sparingly soluble	.. ..	.. ..	.. ..	.. ..	Tartaric and other acids	
,, Valerianate	.. ..	.. ..	.. ..	1·0 to 0·1	.. ..	freely soluble	.. ..	.. ..	.. ..	An acid salt has greater solubility. Authorities differ.
Resorcin........	$C_6H_6O_2$									
Salicine	$C_{26}H_{18}O_{14}$	286·0	.. ..	5·0	200·0	3·0	30·0	insoluble		
Santonine	$C_{30}H_{18}O_6$	246·0	.. ..	almost insoluble	.. ..	2·0	40·0	1·3	liquor potassæ	
Scammonine	.. ..	.. ..	.. ..	insoluble	.. ..	soluble	.. ..	soluble	alkaline solutions	
Silicon..........	Si	21·3								
Silver	Ag	108·0								
,, Acetate ..	AgOAc	167·0	.. ..	1·0	.. ..	.. ..	.. ..	.. ..	cyanide of potassium, &c.	
,, Bromide ..	AgBr	188·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	strong liquor ammonia	
,, Carbonate .	AgO CO_2	138·0	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	liquor ammonia, cyanides, hyposulphites	

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
oluble	.. ..	insoluble	.. ..	insoluble ..	liquor ammonia, cyanide of potassium, hyposulphites	
oluble	.. ..	.. ..	.. ..	.. ..	soluble in acids and ammonia	**Soluble also in solution of monochromate of potash.**
oluble	.. ..	.. ..	.. ..	.. ..	liquor ammonia, alkaline cyanides, &c.	
oluble	.. ..	.. ..	.. ..	.. ..	hot brine, cyanide of potassium, hyposulphites	**Has little solubility in ammonia.**
50·0	any quantity	freely soluble	.. ..	soluble ..	glycerine	**Scarcely soluble in strong nitric acid.**
rly oluble	.. ..	insoluble	.. ..	insoluble		
ghtly oluble	.. ..	.. ..	.. ..	.. ..	alkaline chlorides, cyanides, hyposulphites, &c.	**Oxide of silver dissolves very sparingly in ammonia if the by-products are removed by washing; it then forms**

									pnutes	
Sodium	Na	23·0								
,, Acetate ..	$NaO, Ac\ 6\ Aq$ ..	136·0	.. ..	30·0	150·0	freely soluble				
,, Arseniate	$2\ NaO, HO\ AsO_5 + 14\ Aq$	156·0	.. ..	freely soluble	.. ..	slightly soluble	.. ..	.. ..	.. ..	The other arseniates of soda containing 1 and 3 molecules of NaO are more soluble.
,, ,, Xtl	.. ..	312·0								
,, Arsenite ..	$2NaO, AsO_3$ ..	161·0	.. ..	soluble	.. ..	.. ..	.. ..	.. ..	.. ..	Also $NaO\ AsO_3$ and $NaO\ 2\ AsO_3$, both soluble in water.
,, Benzoate ..	$NaO, BzAq$ ..	153·0	.. ..	soluble	.. ..	slightly soluble	.. ..	.. ..	.. ..	Efflorescent.
,, Borate	$NaO, 2\ BO_3\ 10Aq$	191·0	.. ..	8·0	50·0	insoluble	.. ..	.. ..	glycerine	
,, Bromate ..	$NaO\ BrO_5$.. ..	151·0	.. ..	30·0	90·0					
,, Bromide ..	NaBr	103·0	.. ..	50·0, 90·0	110·0	20·0	.. ..	.. ..	.. ..	Authorities differ.
,, Carbolate..	.. ..	.. ..	.. ..	very soluble	.. ..	.. ..	.. ..	.. ..	carbolic acid	Insoluble in strong soda liquors.
,, Carbonate..	$NaO\ CO_2$	53·0	.. ..	16·6	45·4					
,, ,, Xtls...	$NaO, CO_2, 10\ Aq$	143·0	.. ..	63·0	540·0	.. ..	.. ..	.. ..	.. ..	Said to be more soluble at 100° than at 212° Fahr.
,, ,, Bi- ..	$NaO, HO, 2\ CO_2$	84·0	.. ..	10·0	begins to decompose about 110° F					
,, Chlorate ..	NaO, ClO_5.. ..	106·5	.. ..	100·0	300·0	slightly soluble about 3·0				

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.		Notes.
Cold.	Hot.	Cold.	Hot.				
35·9	39·6	0·5	.. ..	insoluble ..	..	..	Proof spirit dissolves 3 or 4 per cent.
adily soluble	.. ..	sparingly soluble					
ore soluble than monochromate							
luble	.. ..	sparingly soluble					
50·0							
liquescent	.. ..	freely soluble					
70·0	300·0						
10·0	.. ..	insoluble	.. ..	.. ..	..	..	The most soluble of the iodates.
50·0	300·0	sparingly soluble					
liquescent	.. ..						
30·0	200·0	slightly soluble	.. ..	.. ..	..	..	Much more soluble in proof spirit.
ry soluble	.. ..	soluble					
8·0			10·0	insoluble			

	24 Aq									
,, Pyrophosphate	2 NaO, PO_5 10 Aq	223·0	.. ..	soluble	.. ..	insoluble				
,, Salicylate	.. ..	.. ..	.. ..	33·3 to 100·0 soluble	.. ..	14·0	.. ..	.. ..	.. ..	Authorities differ.
,, Sulphate ..	NaO SO_3 10 Aq	161·0	.. ..	40·0	any quantity	insoluble				
,, Sulphide ..	NaS	39·0	.. ..	freely soluble	.. ..	slightly soluble	.. ..	insoluble		
,, ,, Xtl.	NaS 9 Aq	120·0								
,, Sulphite ..	NaO SO_2 10 Aq	153·0	.. ..	31·3	240·0					
,, Sulphocarbol										
,, Sulphovinate	$C_4H_5NaS_2O_8$ 2 Aq	167·0	.. ..	150·0	.. ..	soluble				
,, Tannate ..	$C_{54}H_{20}Na_2O_{31}$ ..	662·0	.. ..	easily soluble	.. ..	insoluble				
,, Tartrate ..	2 NaO, Tr 4 Aq	230·0	.. ..	20·0	200·0	sparingly soluble	.. ..	.. ..	.. ..	Insoluble in absolute alcohol.
,, ,, Bi-	NaO Tr 2 Aq ..	190·0	.. ..	11·0	55·0	insoluble				
,, ,, and Potash	KO,NaO $C_8H_4O_{10}$ 8 Aq	282·0	.. ..	100·0	300·0 to 400·0					
,, Tungstate										
,, Valerianate	NaO, $C_{10}H_9O_3$ ..	124·0	.. ..	very deliquescent	.. ..	very soluble				
Strontium	Sr	44·0								
,, Carbonate	SrO CO_2	74·0	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	.. ..	Strontium salts are not poisonous.
,, Chlorate ..	SrO, ClO_5 5 Aq ..	172·5	.. ..	readily soluble	.. ..	soluble				

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
ery soluble	.. ..	1·0				
00·0	.. ..	sparingly soluble	.. ..	.. .. ..	.. ..	Very little soluble in strong nitric or hydrochloric acid.
2·0	40·0	.. ..	.. ..	.. .. ..	syrup	
soluble	.. ..	insoluble				
0·013; parıngly soluble	.. ..	little soluble	moderately soluble	insoluble ..	chloroform	Insoluble in absolute alcohol.
reely soluble	.. ..	freely soluble				
2·5	.. ..	easily soluble				
2·0	50·0	1·7	50·0	insoluble		
oluble						
2·5	100·0	1·2	100·0			
00·0	500·0	4·0	much more soluble	insoluble ..	.. ..	Almost insoluble in cold absolute alcohol, and much more soluble in spirits weaker than rectified.
81·0	.. ..	3·0	21·0			
18·0	40·0	insoluble	.. ..	insoluble ..	.. .. ..	More soluble in acid or alkaline liquors than in pure

„ Iodide									phide carbon	
Tannin	$C_{54}H_{22}O_{34}$	618·0	.. ..	very soluble	.. ..	very soluble	.. ..	very soluble	glycerine ..	Many acids (HCl, &c.) precipitate tannin from strong aqueous solutions.
Thymol	$C_{10}H_{14}O$	.. ..	.. ..	sparingly	.. ..	100·0				
Tin	Sn	59·0								
„ Chloride ..	SnCl	94·5	.. ..	soluble	.. ..	soluble				
„ „ Bi-	$SnCl_2$	129·0	.. ..	soluble	.. ..	very soluble				
„ Iodide	SnI	186·0	.. ..	sparingly	more soluble					
„ „ Bin-	SnI_2	313·0	.. ..	decomposed	.. ..	.. ..	.. ..	.. ..	.. ..	Soluble in absolute alcohol.
„ Oxalate....	$SnOC_2O_3$	.. ..	.. ..	insoluble						
„ Oxide	SnO_2	75·0	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	.. ..	The hydrated oxide is soluble in acid and alkaline liquors, the anhydrous oxide not so.
Tungsten	W	94·6								
Uranium........	Ur	60·0								
„ Chloride ..	UrCl	95·5	.. ..	deliquescent	.. ..	.. ..	.. ..	.. ..	.. ..	Decomposes on evaporation.
„ Nitrate	$Ur_2O_3\,NO_5$ 6 Aq	252·0	.. ..	200·0	.. ..	300·0	.. ..	25·0		
„ Oxalate ..	$Ur_2O_3\,C_2O_3$ 3 Aq	207·0	.. ..	0·8	3·0	.. ..	.. ..	.. ..	liquor ammonia, alkaline oxalates	

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
nsoluble	.. ..	.. ..	.. ..	.. ..	.. ..	Soluble in acids and alkaline salts. The anhydrous oxide less readily so.
200·0 asily soluble	300·0	soluble 4·0	5·0			
100·0	.. ..	20·0	100·0	very sparingly		
) 12·0 sparingly soluble	freely soluble	sparingly soluble				
nsoluble	.. ..	30·0 readily soluble	50·0	2·0 freely soluble	chloroform, oil, &c.	
30·0	200·0	1·2	3·0			
oluble	.. ..	soluble	.. ..	.. ..	.. ..	Efflorescent
nsoluble	.. ..	.. ..	.. ..	.. ..	soluble in boracic and hydrochloric acids	
eliquescent	.. ..	soluble	.. ..	soluble ..	liquor ammonia	

										cal salts, and the caustic alkalies.
„ „ B.P.	3 ZnO, 3 HO, CO_2	170·0	.. ..	insoluble						
„ Chloride ..	ZnCl	68·0	.. ..	300·0	.. ..	100 0	.. ..	soluble		
„ Chromate ..	ZnO CrO_3 7 Aq ..	153·8	.. ..	soluble						
„ Cyanide ..	ZnCy	58·5	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	liquor ammonia, alkaline cyanides	
„ Iodide	ZnI	159·5	.. ..	230·0	.. ..	soluble				
„ Nitrate	ZnO NO_5 6 Aq ..	148·5	.. ..	very deliquescent	.. ..	very soluble				
„ Oleate										
„ Oxide	ZnO	40·5	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	acid and alkaline liquors	The hydrated oxide is very easily dissolved by acids or caustic alkalies; the anhydrous less so, yet it is much more easily dissolved than some other anhydrous oxides.
„ Phosphate ..	2 ZnO HO PO_5 2 Aq	188·0	.. ..	insoluble	.. ..	.. ..	.. ..	.. ..	phosphoric and other acids	
„ Phosphide ..	ZnP and Zn_3P ..	63·5 128·5	.. ..	insoluble	.. ..	insoluble	.. ..	.. ..	.. ..	Acted on by acids with difficulty.
„ Phosphite ..	2 ZnO, HO PO_3 5 Aq	190·0	.. ..	difficultly soluble						
„ Salicylate ..										
„ Sulphate ..	ZnO, SO_3 7 Aq ..	143·5	.. ..	140·0	653·0					

Solubility in 100 parts water.		Solubility in 100 parts spirit.		Solubility in 100 parts ether.	Other solvents.	Notes.
Cold.	Hot.	Cold.	Hot.			
soluble	.. ..	insoluble	.. ..	insoluble ..	liquor ammonia, cyanide of potassium, hyposulphites	
soluble	.. ..	.. ..	.. ..	.. ..	soluble in acids and ammonia	Soluble also in solution of monochromate of potash.
soluble	.. ..	.. ..	.. ..	.. ..	liquor ammonia, alkaline cyanides, &c.	
soluble	.. ..	.. ..	.. ..	.. ..	hot brine, cyanide of potassium, hyposulphites	Has little solubility in ammonia.
150·0	any quantity	freely soluble	.. ..	soluble ..	glycerine	Scarcely soluble in strong nitric acid.
arly soluble	.. ..	insoluble	.. ..	insoluble		
ightly oluble	.. ..	.. ..	.. ..	.. ..	alkaline chlorides, cyanides, hyposulphites, &c.	Oxide of silver dissolves very sparingly in ammonia if the by-products are removed by washing; it then forms a detonating com-

APPENDIX V.

OF BAUMÉ'S DEGREES FOR LIQUIDS HEAVIER TER, AND TWADDLE'S DEGREES WITH SPECI- TIES.

Twaddle.	Baumé.	Sp. Gr.	Twaddle.	Baumé.	Sp. Gr.	Twaddle.
		1·125	25		1·255	51
1	17	1·126		31	1·256	
		1·130	26		1·260	52
2	18	1·134			1·265	53
		1·135	27	32	1·267	
3		1·140	28		1·270	54
4	19	1·143			1·275	55
5		1·145	29	33	1·277	
		1·150	30		1·280	56
6	20	1·152			1·285	57
		1·155	31	34	1·287	
7	21	1·160	32		1·290	58
8		1·165	33		1·295	59
	22	1·169		35	1·299	
9		1·170	34		1·300	60
		1·175	35		1·305	61
10	23	1·178		36	1·310	62
11		1·180	36		1·315	63
		1·185	37		1·320	64
12	24	1·188		37	1·322	
		1·190	38		1·325	65
13		1·195	39		1·330	66
14	25	1·197		38	1·333	
15		1·200	40		1·335	67
		1·205	41		1·340	68
16	26	1·206		39	1·345	69
17		1·210	42		1·350	70
		1·215	43		1·355	71
18	27	1·216		40	1·357	
		1·220	44		1·360	72
19		1·225	45		1·365	73
20	28	1·226		41	1·369	
		1·230	46		1·370	74
21		1·235	47		1·375	75
	29	1·236			1·380	76
22		1·240	48	42	1·382	
23		1·245	49		1·385	77
	30	1·246			1·390	78
24		1·250	50	43	1·395	79

Baumé.	Sp. Gr.	Twaddle.	Baumé.	Sp. Gr.	Twaddle.	Baumé.	Sp. Gr.	Twaddle.
	1·400	80	57	1·600	120		1·800	160
	1·405	81		1·605	121		1·805	161
44	1·407			1·610	122	68	1·809	
	1·410	82		1·615	123		1·810	162
	1·415	83	58	1·617			1·815	163
	1·420	84		1·620	124		1·820	164
45	1·421			1·625	125		1·825	165
	1·425	85		1·630	126		1·830	166
	1·430	86	59	1·634		69	1·831	
46	1·434			1·635	127		1·835	167
	1·435	87		1·640	128		1·840	168
	1·440	88		1·645	129		1·845	169
	1·445	89		1·650	130		1·850	170
47	1·448		60	1·652		70	1·854	
	1·450	90		1·655	131		1·855	171
	1·455	91		1·660	132		1·860	172
	1·460	92		1·665	133		1·865	173
48	1·462		61	1·670	134		1·870	174
	1·465	93		1·675	135		1·875	175
	1·470	94		1·680	136	71	1·877	
	1·475	95		1·685	137		1·880	176
49	1·476		62	1·689			1·885	177
	1·480	96		1·690	138		1·890	178
	1·485	97		1·695	139		1·895	179
50	1·490	98		1·700	140	72	1·900	180
	1·495	99		1·705	141		1·905	181
	1·500	100	63	1·708			1·910	182
51	1·505	101		1·710	142		1·915	183
	1·510	102		1·715	143		1·920	184
	1·515	103		1·720	144	73	1·924	
52	1·520	104		1·725	145		1·925	185
	1·525	105	64	1·727			1·930	186
	1·530	106		1·730	146		1·935	187
53	1·535	107		1·735	147		1·940	188
	1·540	108		1·740	148		1·945	189
	1·545	109		1·745	149	74	1·949	
	1·550	110	65	1·747			1·950	19

MPARISON OF BAUMÉ'S DEGREES FOR LIQUIDS TER THAN WATER, WITH SPECIFIC GRAVITIES.

ould be noted that the degrees in Baumé's hydro- for liquids lighter than water do not agree even in ro point with those of his hydrometers for liquids than water.

Sp. Gr.	Baumé.	Sp. Gr.	Baumé.	Sp. Gr.	Baumé.	Sp. Gr.
1·000	23	·918	36	·849	49	·789
·993	24	·913	37	·844	50	·785
·986	25	·907	38	·839	51	·781
·980	26	·901	39	·834	52	·777
·973	27	·896	40	·830	53	·773
·967	28	·890	41	·825	54	·768
·960	29	·885	42	·820	55	·764
·954	30	·880	43	·816	56	·760
·948	31	·874	44	·811	57	·757
·942	32	·869	45	·807	58	·753
·936	33	·864	46	·802	59	·749
·930	34	·859	47	·798	60	·745
·924	35	·854	48	·794		

APPENDIX VI.

TABLE OF EQUIVALENT POINTS ON THE BAROMETER SCALES.

Height in inches.		Height in millimetres.	Height in inches.		Height in millimetres.
27·500	equal	698·487	29·400	equal	746·746
27·559	,,	700·000	29·500	,,	749·286
27·600	,,	701·027	29·527	,,	750·000
27·700	,,	703·567	29·600	,,	751·826
27·756	,,	705·000	29·700	,,	754·366
27·800	,,	706·107	29·724	,,	755·000
27·900	,,	708·647	29·800	,,	756·906
27·9527	,,	710·000	29·900	,,	759·446
28·000	,,	711·187	29·921	,,	760·000
28·100	,,	713·727	30·000	,,	761·986
28·149	,,	715·000	30·100	,,	764·526
28·200	,,	716·267	30·118	,,	765·000
28·300	,,	718·806	30·200	,,	767·066
28·346	,,	720·000	30·300	,,	769·606
28·400	,,	721·346	30·314	,,	770·000
28·500	,,	723·886	30·400	,,	772·146
28·543	,,	725·000	30·500	,,	774·685

BLE OF EQUIVALENT POINTS ON THE SCALES OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

Fahrenheit.		Centigrade.	Fahrenheit.		Centigrade.	Fahrenheit.		Centigrade.
2000	equal	1093	194	equal	90·0	95	equal	35·0
1832	,,	1000	190	,,	87·77	90	,,	32·22
700	,,	926	185	,,	85·0	86	,,	30·00
652	,,	900	180	,,	82·22	85	,,	29·44
00	,,	815	176	,,	80·0	80	,,	26·66
72	,,	800	175	,,	79·44	77	,,	25·0
00	,,	760	170	,,	76·66	75	,,	23·88
0	,,	704	167	,,	75·0	70	,,	21·11
2	,,	700	165	,,	73·88	68	,,	20·0
0	,,	649	160	,,	71·11	65	,,	18·33
2	,,	600	158	,,	70·0	60	,,	15·55
0	,,	593	155	,,	68·33	59	,,	15·0
2	,,	500	150	,,	65·55	55	,,	12·77
0	,,	482	149	,,	65·0	50	,,	10·0
0	,,	426	145	,,	62·77	45	,,	7·22
2	,,	400	140	,,	60 0	41	,,	5·0
	,,	371	135	,,	57·22	40	,,	4·44
	,,	315	131	,,	55·0	35	,,	1·66
	,,	300	130	,,	54·44	32	,,	0·0
	,,	260	125	,,	51·66	30	,,	- 1·11
	,,	204	122	,,	50·0	25	,,	- 3·88
	,,	200	120	,,	48·88	23	,,	- 5·0
	,,	149	115	,,	46·11	20	,,	- 6·63
	,,	100	113	,,	45·0	15	,,	- 9·44
	,,	98·88	110	,,	43·33	14	,,	- 10·0
	,,	96·11	105	,,	40·55	10	,,	- 12·22
	,,	95·0	104	,,	40·0	5	,,	- 15·0
	,,	93·33	100	,,	37·77	0	,,	- 17·77
	,,	90·55						

℞. Linimenti Opii ℥vj
Linimenti Camphorae
Comp. ℥ij

M. ft. Lin.
Sig: For External use only
Oct. XXIV 63.

Please to keep this prescription & not
give a copy of it to Mr. B

℞ Quinae disulphatis gr xxx
instilla e limone recente quantum
sufficit succi ad quinam
solvendam et adde
Aquae ℥ x
Strychniae gr i
M. fiat mistura cujus
sumat coch: j maximum
bis die, circa 11mâ a.m
et 4tâ horâ p.m.

March 21/60

Inf: Salviae ℥viii
Muriat: ammon
ʒii
Mell: Rosarum ℥ij
~~m ft collut: oris~~
m ft Gargarisma
Utatur saepe de
die

Servant of Mr
Anderson

Mrs Sh

℞ Ext Aloes Co
Ext Hyoscy
Pil Rhei Comp aa gr iss ~~ft~~
ft Pil i om nocte Caps
Mitte XIV

Dec Taraxaci
Inf Gent Comp aa ℥viii
Soda Bicarb ℥ss
Bismuth Tris Nit ℥ii ~~ft~~
℥i bis die

℞ Ol Croton Ol olive
Gtt - Tinct aa ℥i ft Lini
om nocte appl

APPENDIX VI.

TABLE OF EQUIVALENT POINTS ON THE BAROMETER SCALES.

Height in inches.		Height in millimetres.	Height in inches.		Height in millimetres.
27·500	equal	698·487	29·400	equal	746·746
27·559	,,	700·000	29·500	,,	749·286
27·600	,,	701·027	29·527	,,	750·000
27·700	,,	703·567	29·600	,,	751·826
27·756	,,	705·000	29·700	,,	754·366
27·800	,,	706·107	29·724	,,	755·000
27·900	,,	708·647	29·800	,,	756·906
27·9527	,,	710·000	29·900	,,	759·446
28·000	,,	711·187	29·921	,,	760·000
28·100	,,	713·727	30·000	,,	761·986
28·149	,,	715·000	30·100	,,	764·526
28·200	,,	716·267	30·118	,,	765·000
28·300	,,	718·806	30·200	,,	767·066
28·346	,,	720·000	30·300	,,	769·606
28·400	,,	721·346	30·314	,,	770·000
28·500	,,	723·886	30·400	,,	772·146
28·543	,,	725·000	30·500	,,	774·685

E OF EQUIVALENT POINTS ON THE SCALES OF THE AHRENHEIT AND CENTIGRADE THERMOMETERS.

n-		Centigrade.	Fahrenheit.		Centigrade.	Fahrenheit.		Centigrade.
	equal	1093	194	equal	90·0	95	equal	35·0
	,,	1000	190	,,	87·77	90	,,	32·22
	,,	926	185	,,	85·0	86	,,	30·00
	,,	900	180	,,	82·22	85	,,	29·44
	,,	815	176	,,	80·0	80	,,	26·66
	,,	800	175	,,	79·44	77	,,	25·0
	,,	760	170	,,	76·66	75	,,	23·88
	,,	704	167	,,	75·0	70	,,	21·11
	,,	700	165	,,	73·88	68	,,	20·0
	,,	649	160	,,	71·11	65	,,	18·33
	,,	600	158	,,	70·0	60	,,	15·55
	,,	593	155	,,	68·33	59	,,	15·0
	,,	500	150	,,	65·55	55	,,	12·77
	,,	482	149	,,	65·0	50	,,	10·0
	,,	426	145	,,	62·77	45	,,	7·22
	,,	400	140	,,	60 0	41	,,	5·0
	,,	371	135	,,	57·22	40	,,	4·44
	,,	315	131	,,	55·0	35	,,	1·66
	,,	300	130	,,	54·44	32	,,	0·0
	,,	260	125	,,	51·66	30	,,	- 1·11
	,,	204	122	,,	50·0	25	,,	- 3·88
2	,,	200	120	,,	48·88	23	,,	- 5·0
	,,	149	115	,,	46·11	20	,,	- 6·66
2	,,	100	113	,,	45·0	15	,,	- 9·44
0	,,	98·88	110	,,	43·33	14	,,	- 10·0
5	,,	96·11	105	,,	40·55	10	,,	- 12·22
3	,,	95·0	104	,,	40·0	5	,,	- 15·0
0	,,	93·33	100	,,	37·77	0	,,	- 17·77
5	,,	90·55						

Please to keep this prescription & no
give a copy of it to Mr. B

℞ Quinæ disulphatis gr XXX
instilla e limone recente quant:
sufficit succi ad quinam
solvendam et adde
Aquæ ℥ x
Strychniæ gr I
M. Fiat mistura cujus
sumat coch: j maximum
bis die, circa $11^{\text{mâ}}$ a.m
et $4^{\text{tâ}}$ horâ p.m.

March 21/60

Please to keep this prescription & not
give a copy of it to Mr. B

℞
Quinae disulphatis gr. XXX
in stilla e limone recente quantum
sufficit succi ad quinam
solvendum et adde
Aquae ℥ x
Strychniae gr. 1
M. fiat mistura cujus
sumat coch: j maximum
bis die, circa $11^{\text{mâ}}$ a.m
et $4^{\text{tâ}}$ horâ p.m.

March 21/60

Inf: Salviae ℥viii
Muriat: ammon
ʒii
Mell: Rosaceum ℥ij
~~m ft collut: [illegible]~~
M ft Gargarisma
Utatur saepe de
die

Servant of Mr
Anderson

Mrs [illegible] 0

℞ Ext Aloes Co
Ext Hyoscy
Pil Rhei Comp aa gr iss ~~M~~
ft Pil om nocte Cap
Mitte XIV

℞ Dec Taraxaci
Inf Gent Comp aa ℥viii
Soda Bicarb ʒss
Bismuth Tris Nit ʒii ~~M~~
ft ℥i bis die

5/69 ℞ Ol Croton Ol olive
Chl-Tinct aa ℥i M ft Lini
om nocte appl

Herri Bijhorspt gr xx

Jacchaw alle Zÿ

Agme Zÿ

Yadd [illegible] bischie

Mrs. E

℞ Pulv. Opii comp. gr. x

& Pulv. herb. [illegible] [illegible]

Liquor. sum. Müller

Aug. Xbr 11

Rx Taraxaci
gr XXXVII

Fellis Bov: Inspiss
gr XXIV

M. ft. pil: XII

Cap: i bis in die

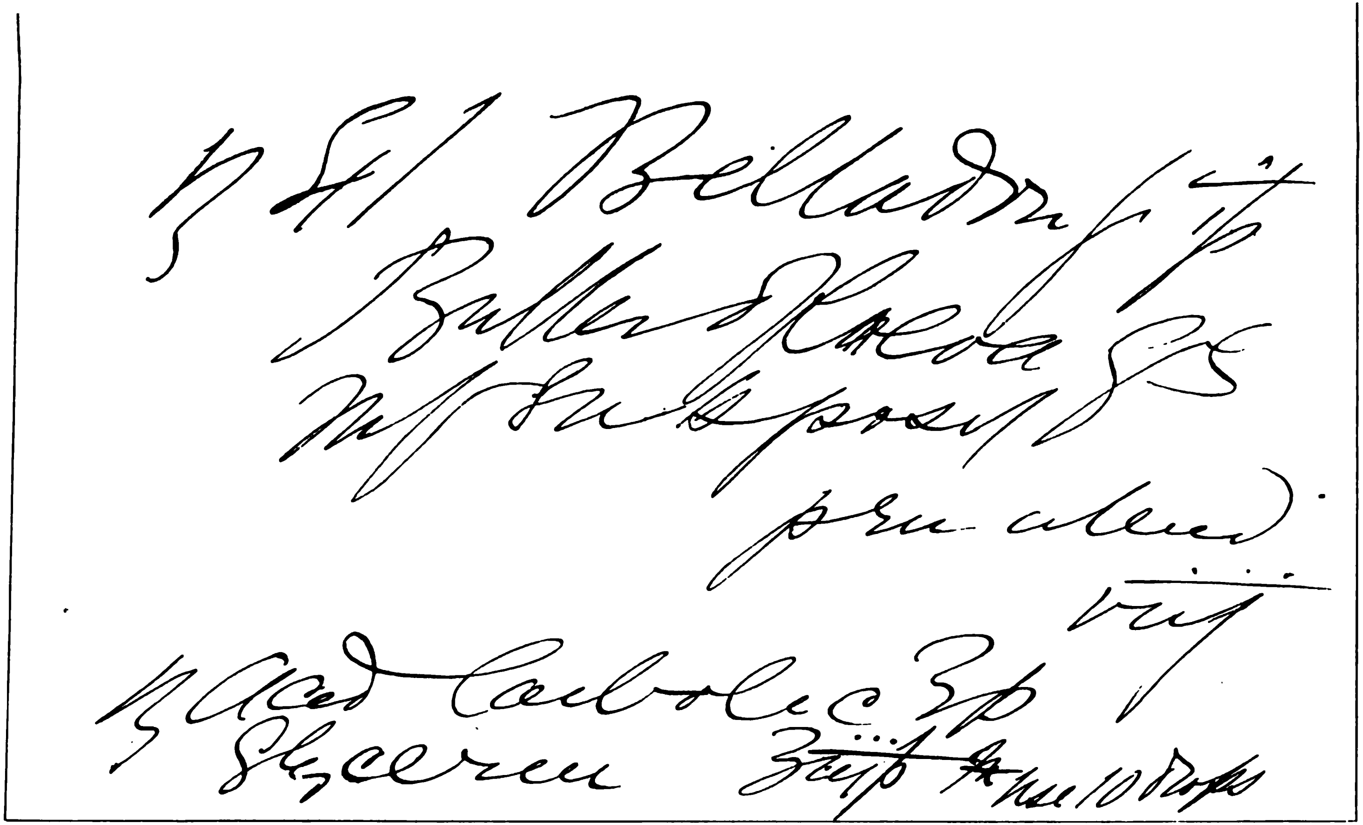
Jan 29 1863.

Miss E

℞ Extr. Aloes aquos gr 1/4
Ferri Sulphat gr 1/4
Extr Hyoscyam
— Gentian comp gr ii

Ft
Pilula semel vel bis die
capienda *. xiv

Die Aprilis 23 1856
at Meal times



℞ Ext. Belladon. gr. ij
Butyr. Cacao ʒiss
M. ft. suppos. ss
pr. un. alvum:
viij

℞ Acid Carbolic ʒss
Glycerin ℥iij ft. Use 10 Drops

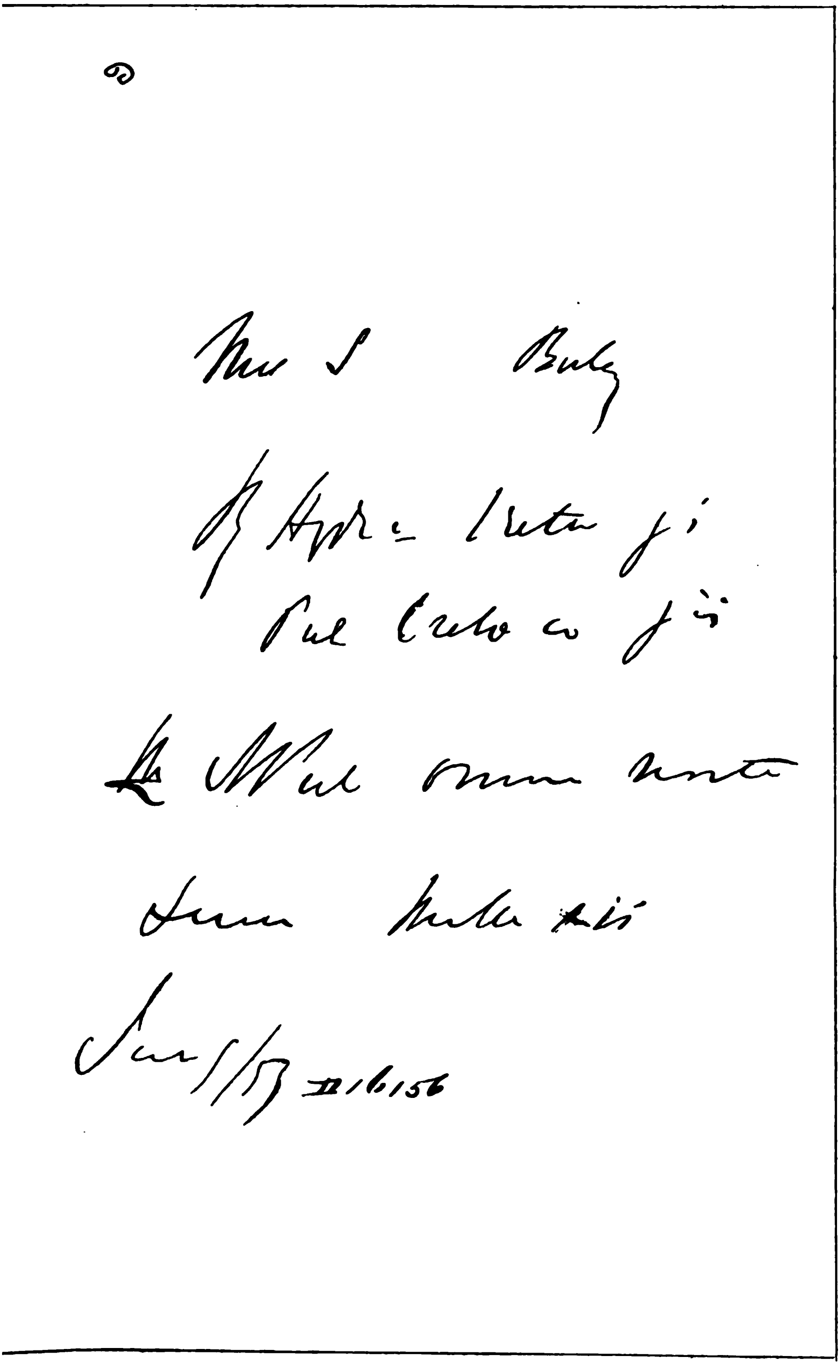
Miss C

Sol. Tinc: Iodin: C ℥iv

& The Iodine paint

for external application

Aug 13/68.

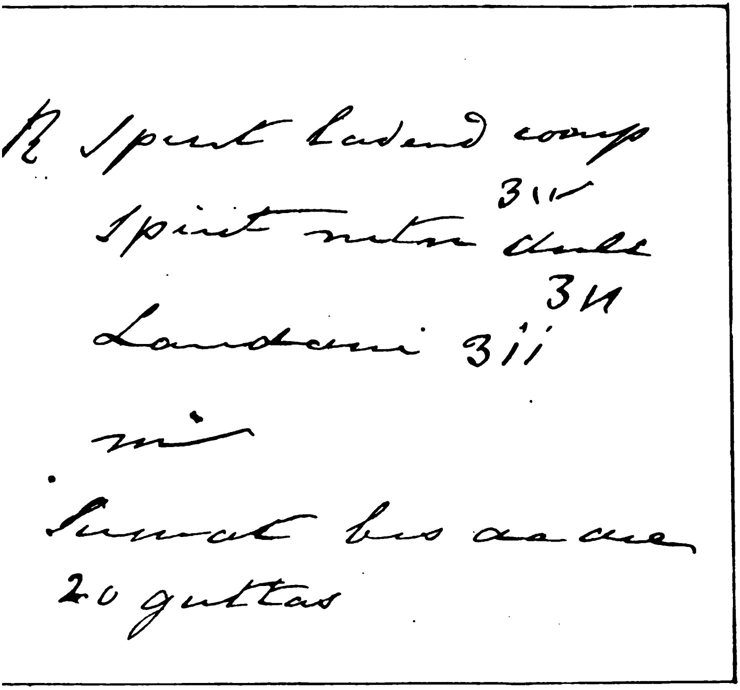


Mrs S Bailey

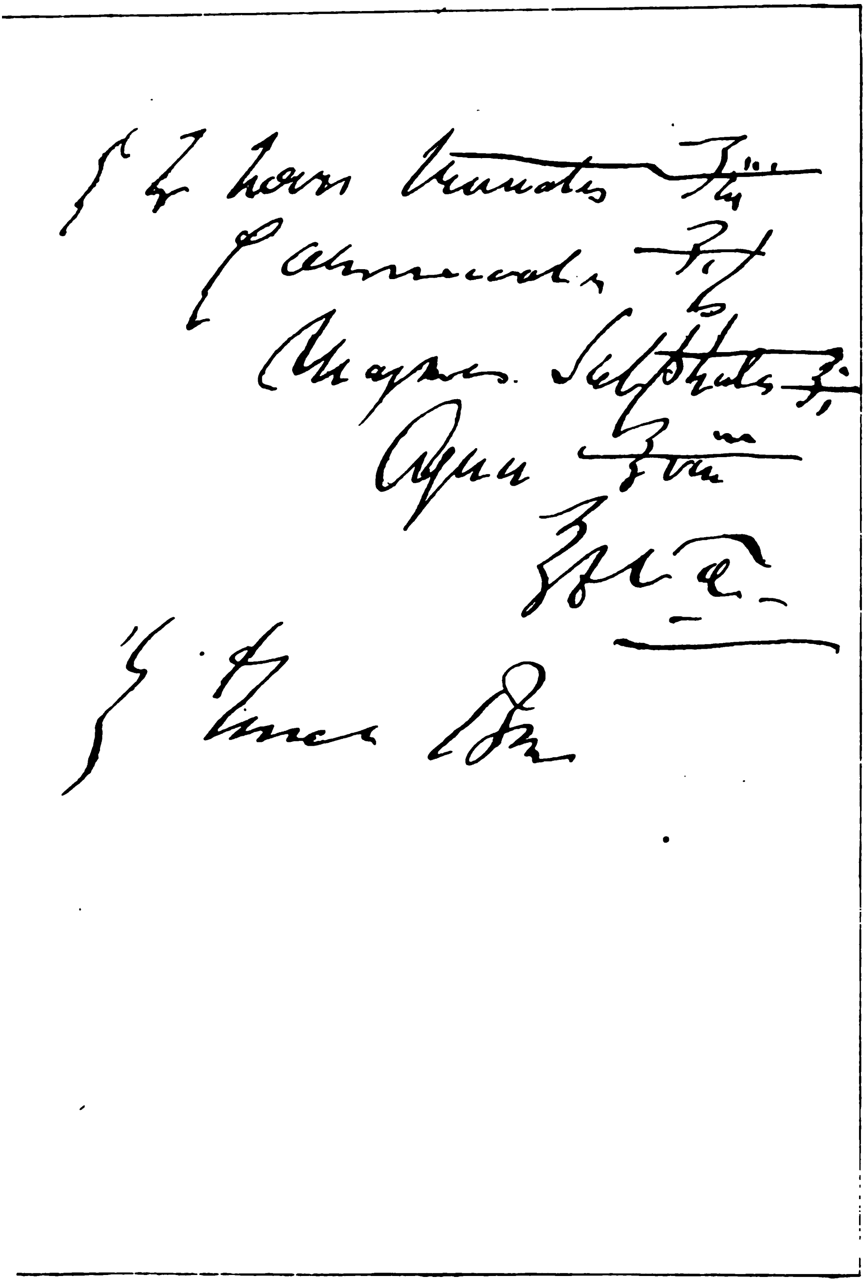
℞ Hydr c Creta ʒi
Pul Creta co ʒii

ft Pul omni nocte
sumen Mitte xii

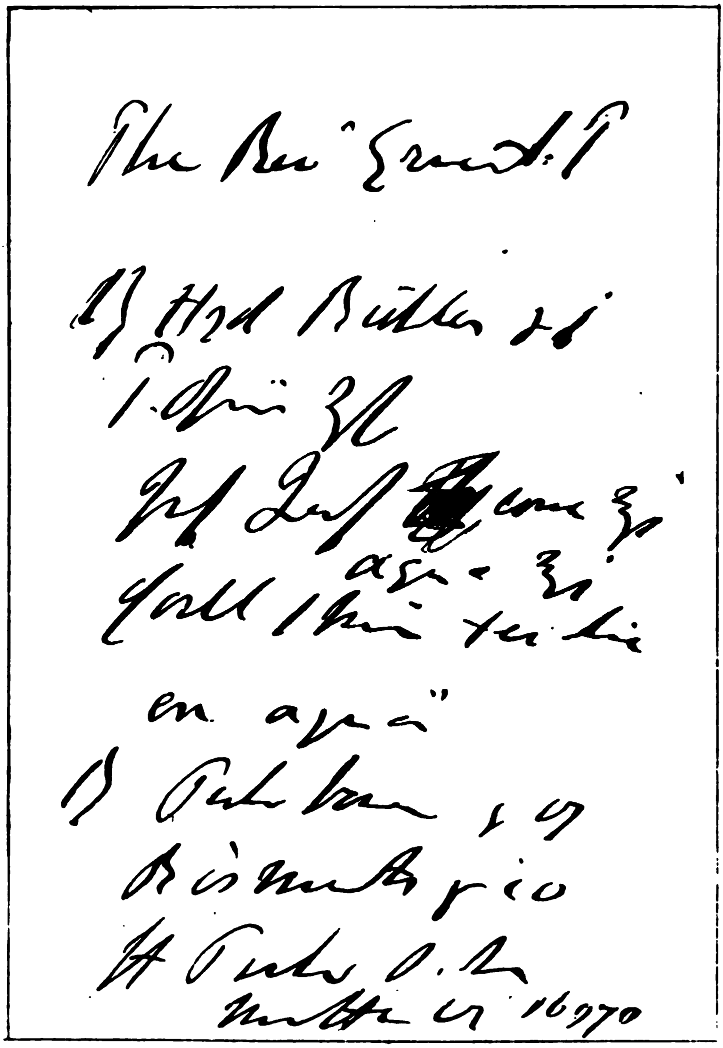
Jun 1/57 II/6/56



℞ Spirit Lavend comp
ʒii
Spirit nitri dulc
ʒii
Laudani ʒii
M
Sumat bis in die
20 guttas



℞ Tr. Nucis Vomicae ʒiii
Sp. Ammoniae ʒi
Magnes. Sulphatis ℥i
Aquae ℥viii
ʒss [illegible]
ʒi. Tinct. [illegible]



The Rev^d [illegible]

[illegible] Hyd Butler [illegible]

[illegible]

[illegible]

[illegible]

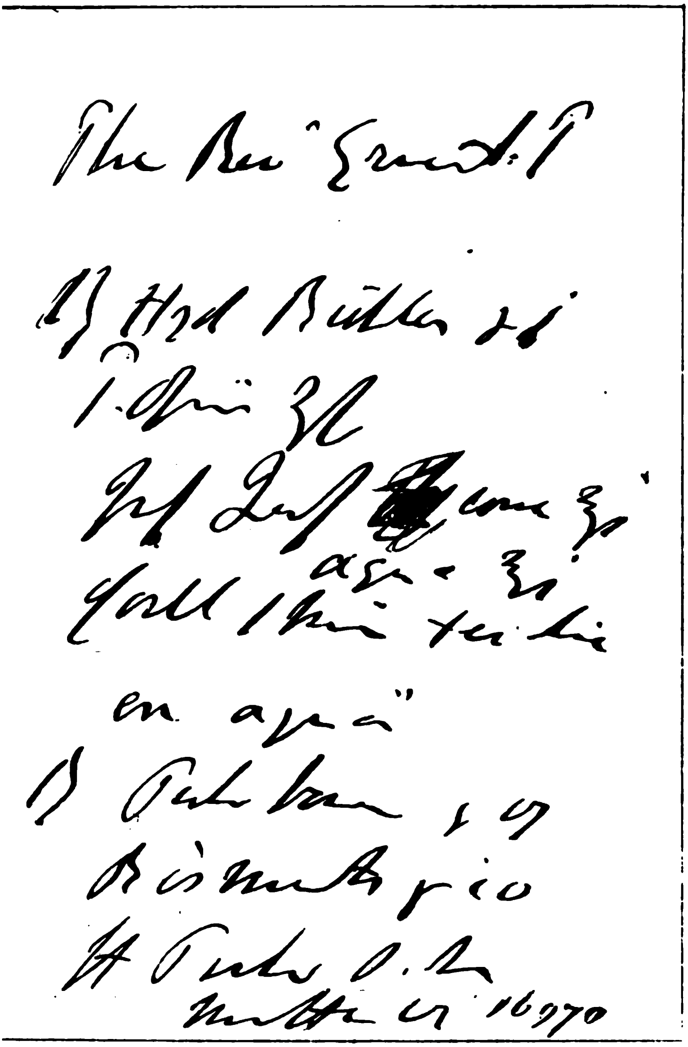
en aqua

[illegible]

Bismuth [illegible]

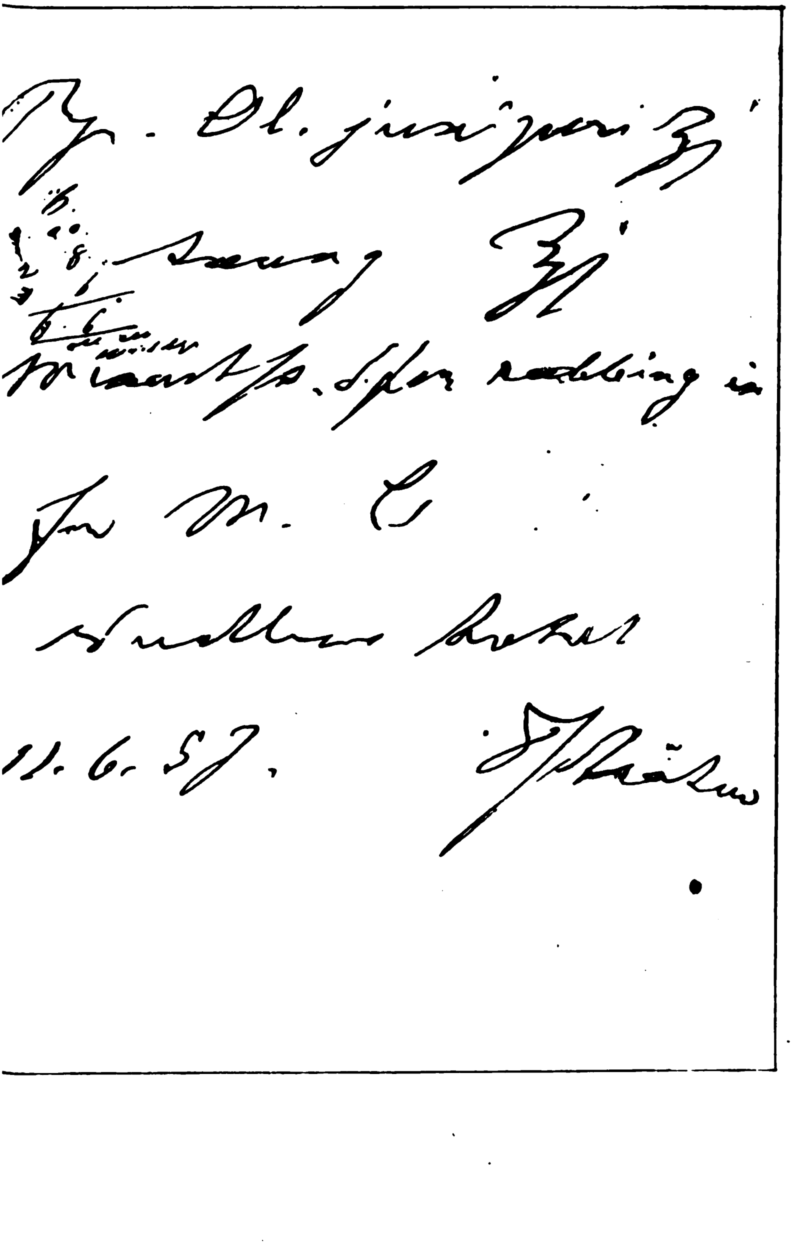
[illegible]

[illegible] 16970

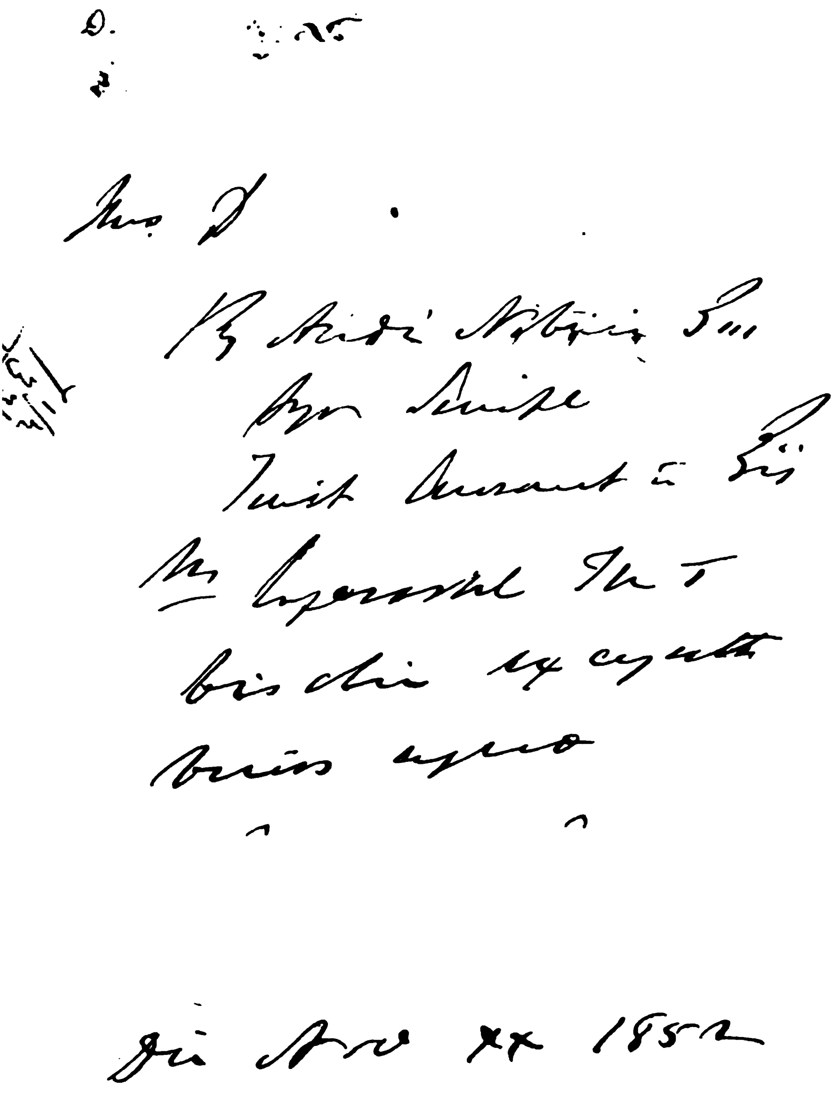


The Revd Ernest [illegible]

℞ Hyd Bichlor gr i
[illegible] ʒii
[illegible] ʒi
[illegible] ter die
ex aqua
℞ [illegible] gr [illegible]
Bismuth gr 10
H [illegible]
[illegible] 16970



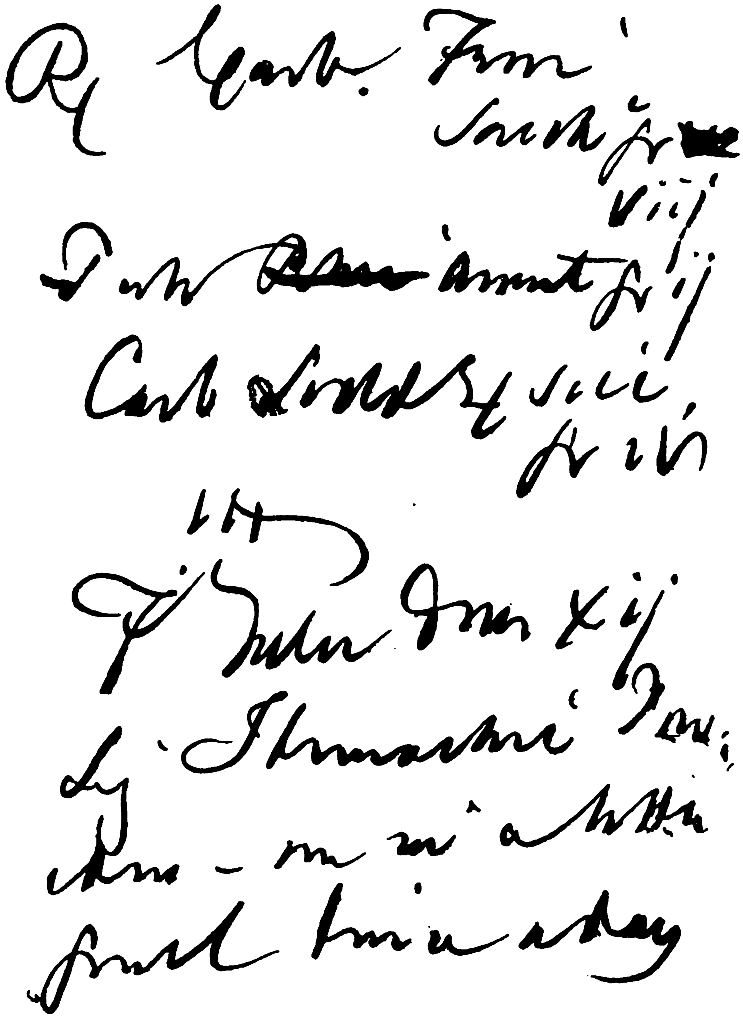
11. 6. 57.



Mr. D

By Aidi Nibiir Bm
Byr Auile
Twit Arnant ē Bii
Mr Coperatel The T
bis chi ey cyatt
bris ayno

Jin Nov XX 1852



R Carb. Ferri
Sulph gr [illegible]
viij
Pulv ~~[illegible]~~ Aromat gr ij
Carb Sodae gr xii
gr iii
M ft
Ft Pulv. Div. xij
Sig. Thomasine Dav.
One — one in a little
fruit twice a day

Mrs W

℞ Pilul Hydrarg ℈i
— Rhei co ℈ii M

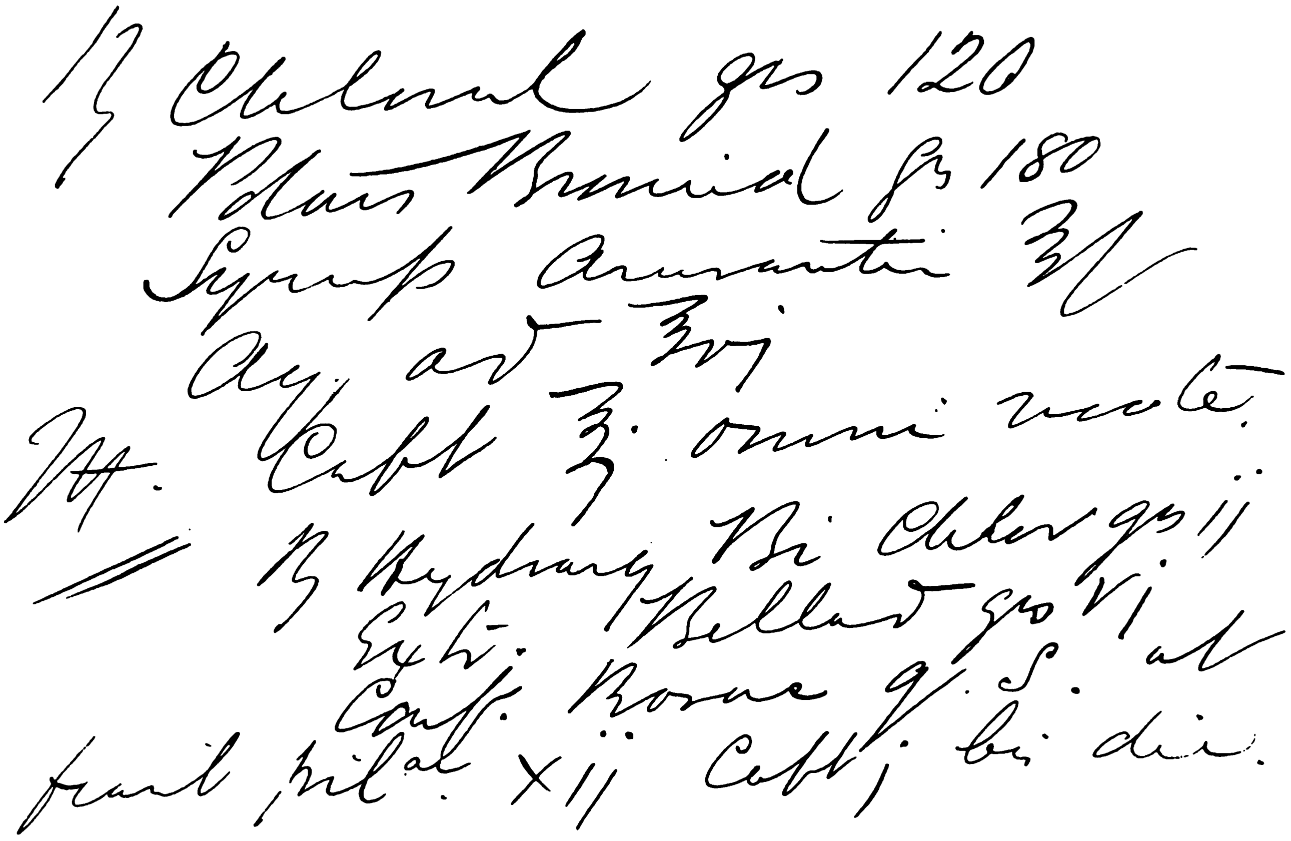
ft Pilul xii

Capiat ii h.s., 2. n.m.

℞ Magnes Carb
~~Soda Carb~~
Magnes Carb aa ʒi
Aqua ℥viiss
Vin Ipecac ʒii
Tinct Zingib ʒii M

Capiat cochl ii mane post
Ablutions.

Die Aug 26 1854



℞ Chloral grs 120
Potass Bromid grs 180
Syrup Aurantii ℥ss
Aq. ad ℥vj
M. Capt ℥i omni nocte.
//
℞ Hydrarg Bi Chlor grs ij
Ext. Bellad grs vj ut
Conf. Rosae q.s.
fiant pil. XII Capt j bis die.

Hyd. Bichlor: gr ½
Tinct: Cinch: co: ℥j.
Aqua ℥vj
Cochl i min. bis die
ex aquâ

℞ Ext Belladon gr $\frac{1}{6}$
Pulv opii gr $\frac{1}{4}$
ft Pil
om noct

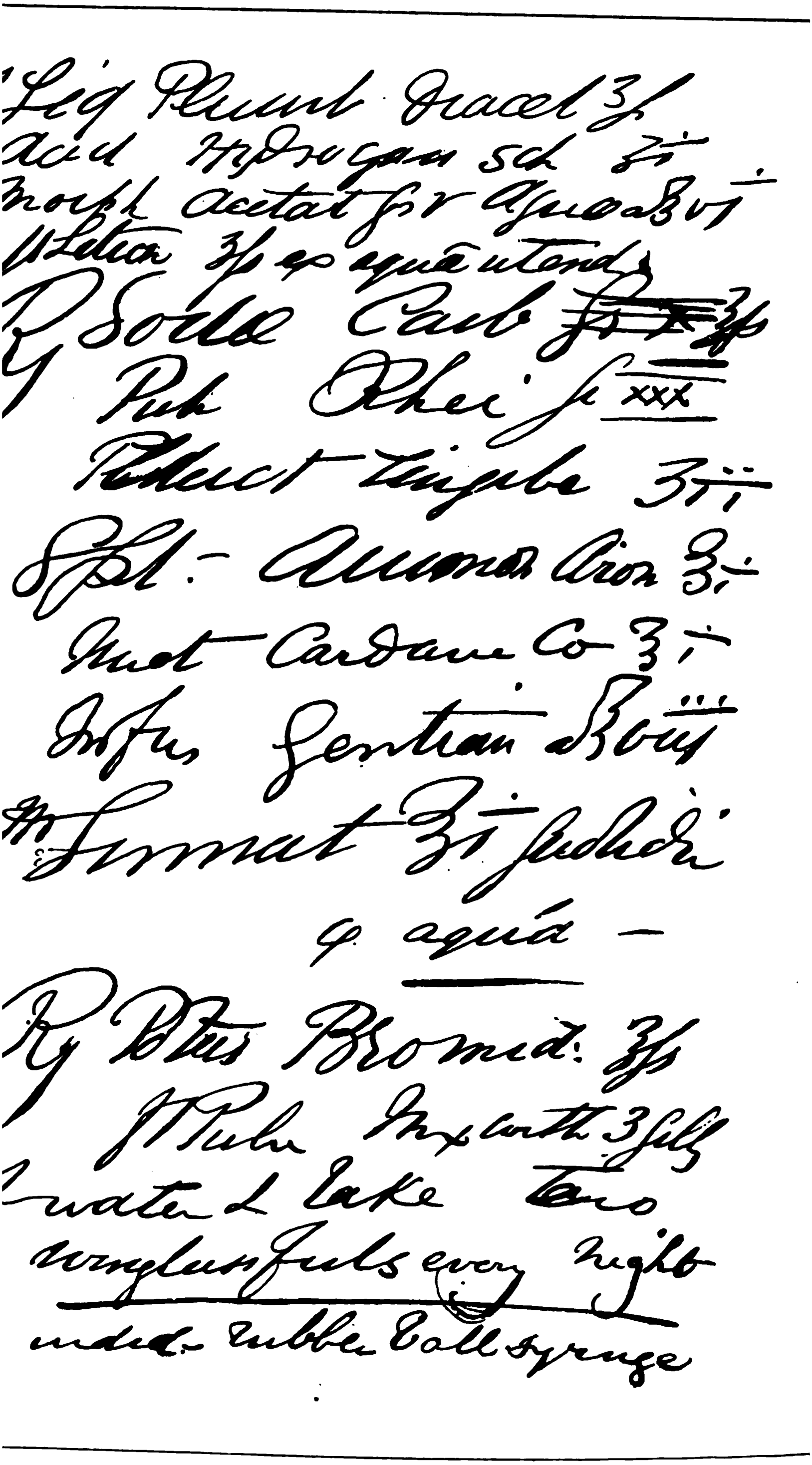
℞ Æther Chloric
Sp. Ammon. C. āā ʒss 4/6
Tr. Card. C. ʒij
Aq. Font. ℥i ad

℞. Aloës Barb— gr XXIV
acid sulph. fort ♏ vj
M ft divide in pil vj
Two to be taken every four
hours until the bowels are
relieved —

℞. Sennæ fol ʒiv
Mag sulph ℥iss —
Syrup Rhamni
Tinct Jalapæ āā ℥ij
Tinct Zingib ʒij
~~aqua~~ Infuse in
aqua ℥vj
ʒiss 2dis horis donec
alv respond

Mrs Z.
℞ Potass. Iodid. gtt ʒi
Ferri Am. cit ʒiss
aqua ad ℥viij M ft s
Inst cujus St ʒss ter die

℞ Argenti nit. gr. IIII.
Aqua distill. ℥i
Solutio
Omni. ff



Liq Plumb Diacet ʒss
Acid Hydrocyan sol ʒii
Morph Acetat gr v Aqua ℥vi
Utere ʒss ex aqua utend

℞ Soda Carb ~~℥i~~ ʒss
Pulv Rhei gr xxx
Pulv Zingib ʒii
Spt. Ammon Arom ℥i
Tinct Cardam Co ℥i
Infus Gentian ℥viii
M Sumat ℥i jentaculi
ex aqua

℞ Potass Bromid ʒss
ft Pulv Mix with 3 gills
water & take two
wineglassfuls every night
[illegible] rubber ball syringe

Sept 21 '72

1 J.

℞ Bismuth albi
ʒij
Tinct Card Co
ʒss Acid Nit dil
Mur Tr. aa m̄ XVI
Infus Quassiae
ad ℥viii M S ʒss
ter die ex aqua
℞ Pil Col Co XII
S ij p.r.n.

℞ Bism: ath Trisnit ℥iß
— Liquor ℥ß
Glycerin ʒß
Liquor Potas ʒij
Chlorodyne ʒj
Acid Hydrocy: Dil: ♏ 50
Ext: Belladonnæ grij
T. Calumb. ℥iß
Aq: —— ad ℥x M
ʒß ter in die s_

Emp Belladonnæ C.
5 inchs × 4. In regin-abdomin
umbilico
Oct 21/71.

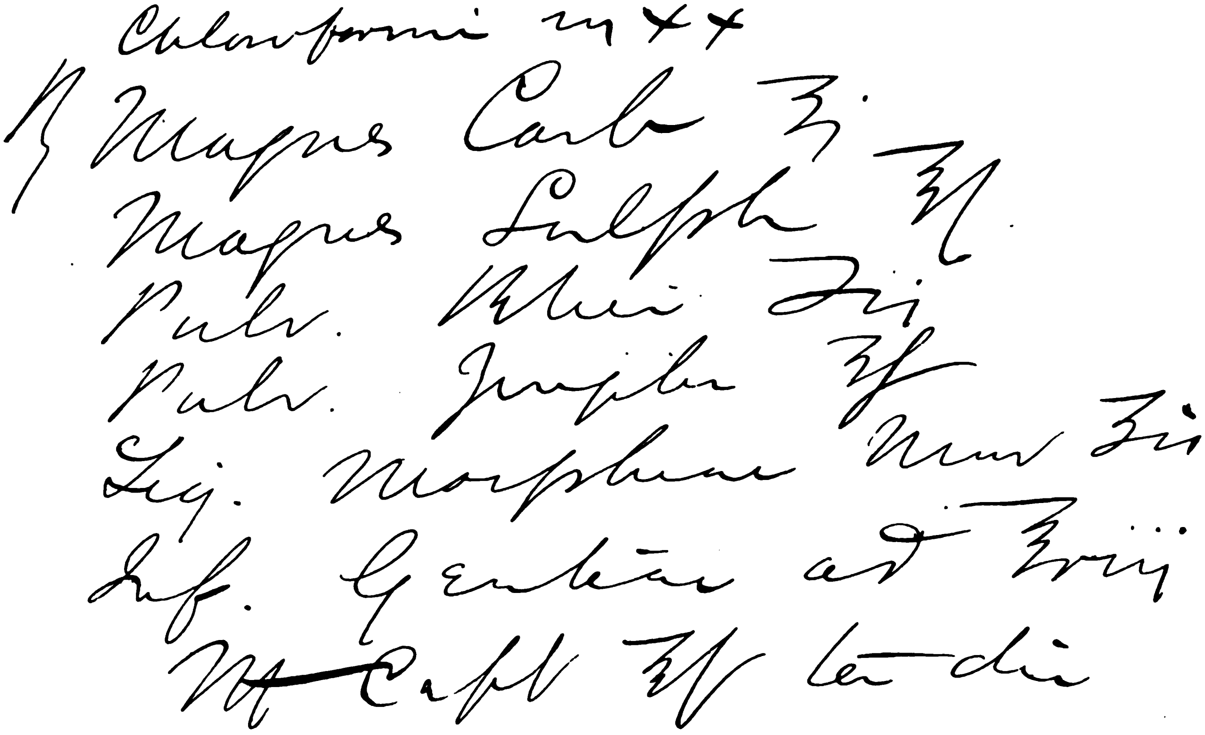
For Mrs C

Rx: Magnes. Sulph ʒiv
Acid. Sulph Dil ʒss
Syr. Zingib ℥ss
Tinct Aurantii ʒiii
Inf Aurantii Co ad ℥viii

Ft Capt ℥i ter die.

4 Dec 1872

Decr 9. 1872
Rep Mist cum Magnesiae
Sulphatis ʒiv ad ℥viii


Chloroformi ♏ xx
℞ Magnes. Carb. ʒi
Magnes. Sulph. ʒß
Pulv. Rhei ʒi
Pulv. Zingiber ʒß
Liq. Morphinae Mur. ʒii
Inf. Gentianae ad ʒviij
Mt. Capt ʒß ter die

Miſs E.

℞ Hydr Chlor gr xx
Succ Hyoscy ʒi
Aqua ʒix M.

(Draught to be taken at bed time.)

Nov 9/72

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